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# The Sewickley Cantilever Bridge

A notable cantilever bridge was built across the Ohio River at Sewickley, Penn., about 12 miles below the "Point" at Pittsburgh, in 1911. It was completed a little more than a year ago. Its channel span is not very much less than that of the other Ohio cantilever bridges, as may be seen from the following list of large American cantilever bridges:

| Bridge | River | Max. Span. ft. |
|---|---|---|
| Quebec (not yet built) | St. Lawrence | 1800 |
| Blackwells Island | East | 1182 |
| Wabash | Monongahela | 812 |
| Memphis | Mississippi | 790 |
| Beaver | Ohio | 769 |
| Sewickley | Ohio | 750 |
| Mingo | Ohio | 700 |
| Thebes | Mississippi | 671 |

A number of the constructive features of the bridge are particularly interesting. This will appear from the following description.*

HISTORY—Agitation for a bridge over the Ohio River at Sewickley dates back to 1894, but the movement set on foot at that time did not succeed; Allegheny County, which was to build the bridge, did not consider the probable benefits of the bridge sufficient to warrant its cost. In 1906 a new movement for a bridge was initiated, and this was approved by the County Court late in that year. General plans were drawn and the approval of the War Department secured during the latter part of 1907, and final plans were prepared in 1908 by the county engineer. On July 2, 1909, a contract for the superstructure was let to the Fort Pitt Bridge Works, and on July 6 a contract for substructure and approaches to Adam Laidlaw Co., both Pittsburgh concerns. On May 16, 1911, the suspended span was closed and the bridge swung. The structure was opened to traffic in the fall of 1911.

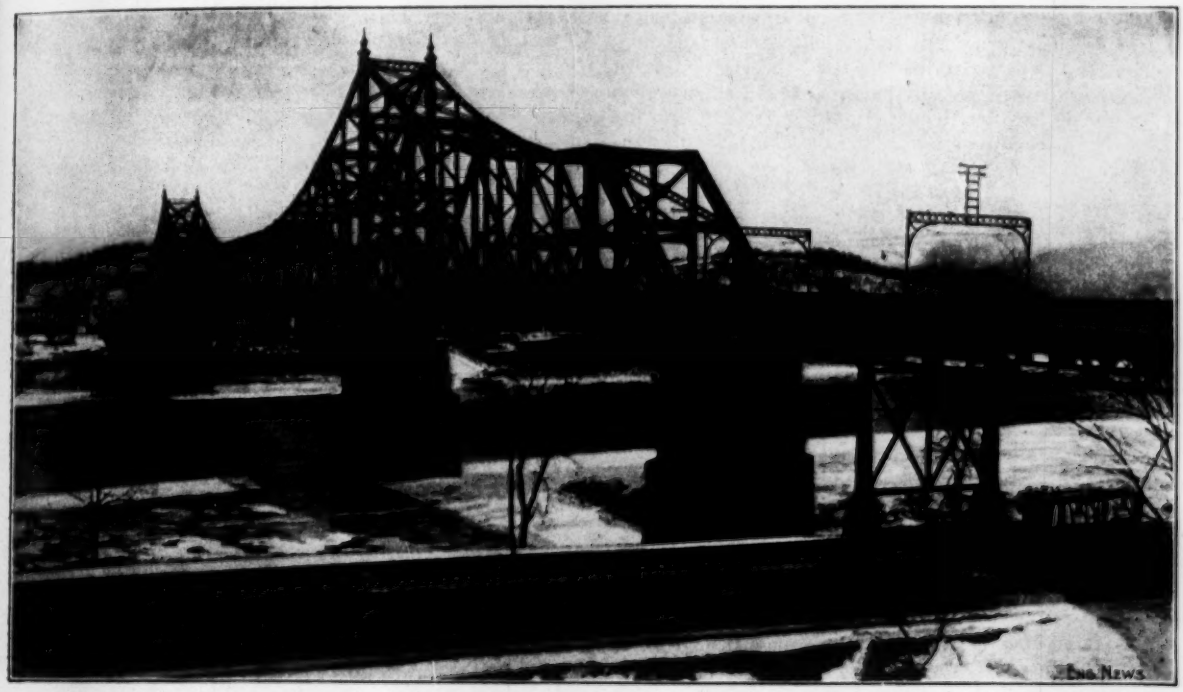



FIG. 1. SEWICKLEY CANTILEVER BRIDGE, OHIO RIVER

## GENERAL DESIGN

The general laws governing bridges over the Ohio River require a minimum span of 500 ft., and a high-water clearance of 50 ft. and low-water clearance of 90 ft. for a 500-ft. width. The War Department has required longer spans than 500 ft. for Ohio River bridges, however, and with due reference to the spans of the near-by Wabash and Beaver bridges the county engineer decided on a span of 750 ft. for Sewickley. There is no

*Two articles on the bridge have been published recently: A. W. Buel, "The Sewickley Cantilever Bridge Over the Ohio River," Proc. Am. Soc. C. E., Sept., 1912, p. 1057; and V. R. Covell, "The Ohio River Highway Bridge at Sewickley," Proc. Engrs. Soc. of Western Penn., Oct., 1912. The former covers the superstructure in detail, while the latter gives information on surveys, substructure, etc. The two articles together describe the bridge quite completely.

bridge between Sewickley and the Point at Pittsburgh, where the Ohio is formed by the confluence of the Allegheny and Monongahela Rivers.

While the bridge was to be designed for ordinary highway loading (including a double-track electric-railway line), and therefore suspension-bridge construction could be considered, yet the available anchorage space at the end was not adequate for this type, and a cantilever span was the only kind seriously considered. The river regulations necessitated erection without falsework.

J. G. Chalfant, county engineer of Allegheny County, prepared the working plans for the substructure and general design plans for the steelwork. The foundations and piers were built in accordance with these plans. The steel superstructure was built to the designed outline and loading, but was changed in a number of details by the contractor's engineers as the result of a complete study of the design. This involved, as one important feature, a considerable increase in the weight of the bridge.

The War Department permit fixed the location of the bridge within very narrow limits, so that the subsequent fieldwork of location involved nothing more than suitable triangulation to set the piers. The bridge crosses the high-water channel at right angles, and extends from the easterly side of Chadwick St., Sewickley, between River Ave. and Chestnut St., to a point north of Coraopolis. The triangulation was made by laying down a rhomboid with the bridge axis as its short diagonal, comprising two shore bases 1150 and 1350 ft. long, which gave angles to the opposite ends of the bridge axis of about 47°. Careful work by ordinary methods yielded a bridge-axis measurement exact within 1/8 in.

The bridge is 1852 ft. 7 in. long between abutments. It comprises six approach spans and a three-span cantilever bridge 1350 ft. long, all of steel, the approach spans being supported by steel bents, while the main and anchor piers are of masonry up to the bridge-seats. The spans are as follows, beginning on the south shore: Approach spans of 75 ft. 2 in., 108 ft. 9 in. (over Pittsburgh & Lake Erie Ry.), and 75 ft. 2 in.; south anchor arm, 300 ft.; channel span, 750 ft., consisting of two cantilever arms of 200 ft. each, and a suspended span of 350 ft.; north anchor arm, 300 ft.; north approach spans, three of 75 ft. 2 in., the last one crossing Chadwick St., in Sewickley. The trusses are spaced 32 ft. center to center throughout, giving a roadway 28 ft. wide in the clear; their planes are vertical. Outside of the trusses are sidewalks 7 ft. 9 in. wide from center of truss to center of

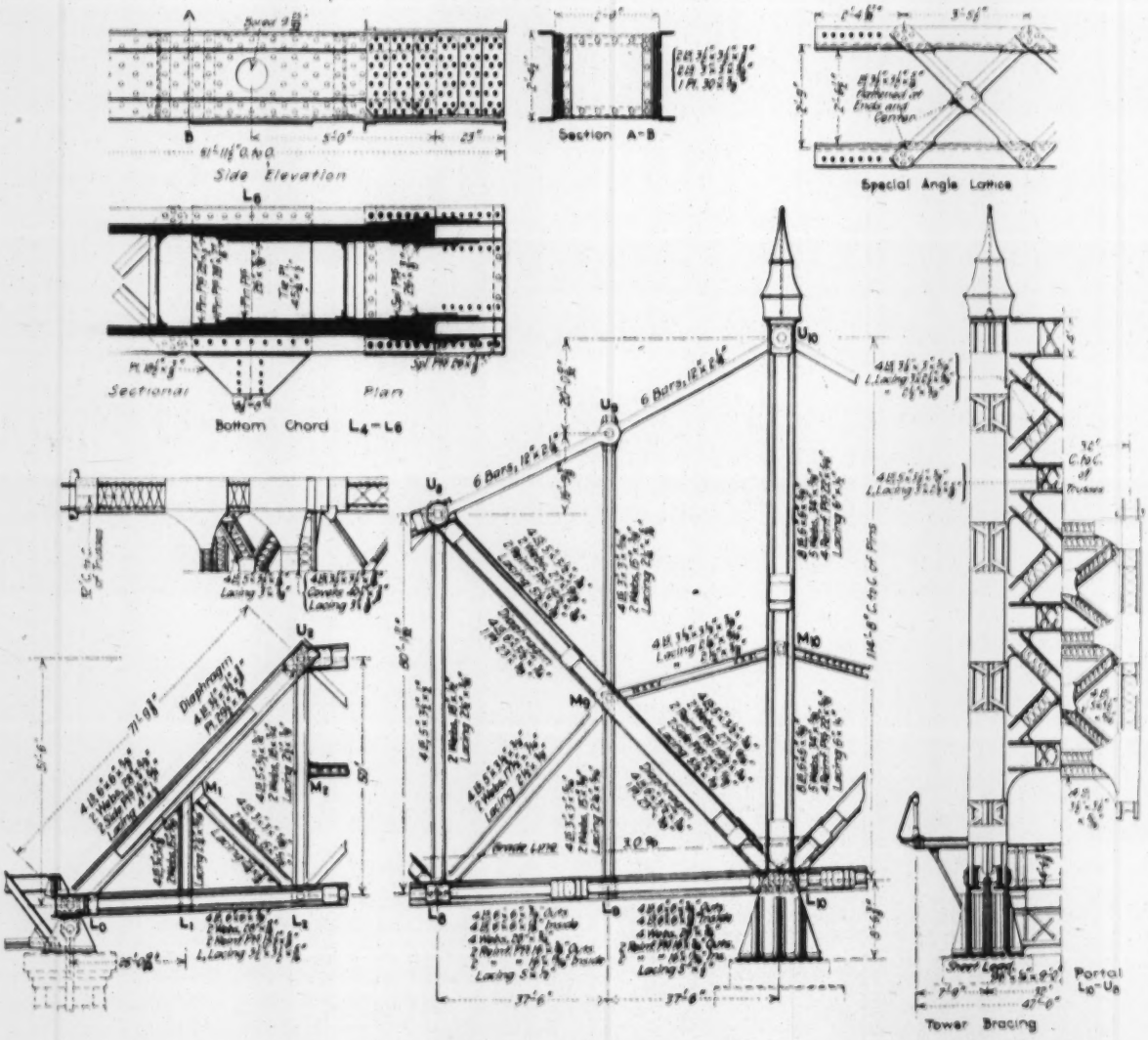



FIG. 2. TYPICAL DETAILS

railing, carried on cantilever brackets attached to the posts. The roadway has a solid-floor construction of wood block on concrete on buckle-plates. The street-car tracks are laid adjoining the trusses, with the roadway in the center, as the width was not sufficient for four lines of travel. The county laid the tracks, and rents them to the street-railway company using them.

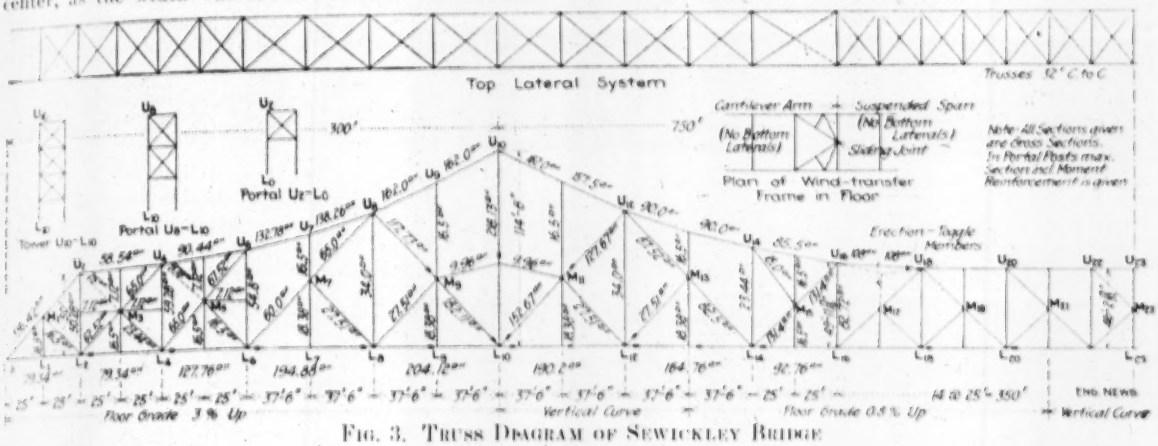



FIG. 3. TRUSS DIAGRAM OF SEWICKLEY BRIDGE

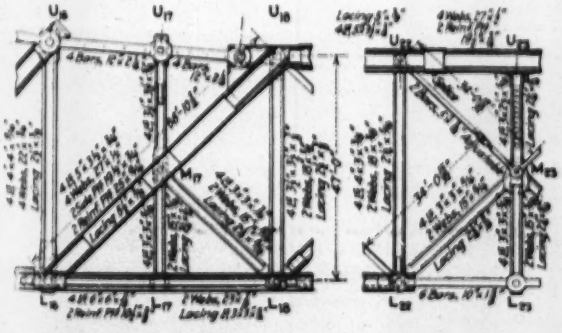
In profile, the bridge has 3% grade up toward the river on each side as far as the main piers, and 0.8% grade on the flanks of the channel span, with vertical curves connecting at the center and at the main piers to the adjoining grades.

## SUBSTRUCTURE

The foundations were not difficult. Rock is not far below the surface and the earth over it is good. The piers, pedestals and abutments on land were built in open excavation. The river piers were built in open coffer-dams driven to rock, which were to be pumped out dry for concreting. But it did not prove possible to drain them entirely, and the lower 10 ft. of concrete in the river piers was deposited under water.

All parts of the substructure are of concrete, but the main and anchor piers of the cantilever bridge are faced with sandstone, and the caps of the pedestals and the bridge-seats of the abutments are also of sandstone. Beaver Valley sandstone obtained from Wampum, Penn., and Morgantown, W. Va., was used. The largest pieces were the granite bridge-seats on the main piers, each consisting of two slabs 4 ft. by 11 ft. by 3 ft. thick, joined on the longitudinal center line of the truss, making the bridge-seat 8x11 ft. by 3 ft. thick.

The two river piers were founded in 14 ft. and 6 ft.



OF SEWICKLEY BRIDGE

of water, respectively. The subsoil is sand and gravel with rock at comparatively shallow depth. The two piers went to 33 and 30.9 ft., respectively, below pool-full level. The lower part of each pier is 71x26 ft., and the coffer-dam was made 76x28 ft., to give room for forms. After dredging the pier site to rock, the coffer-dam was built in place by floating out rings of 12x12 timbers to form the inner bracing and driving sheathing on the outside to rock. Backfill of clay was deposited around the sheathing to seal the coffer-dam, and then the inside was cleaned down to rock with a clam-shell bucket and pumped out. The coffer-dam leaked sufficiently, however, that the break-down of one of the pumps led to a decision to deposit the lower 10 ft. of concrete under water. When this concrete had set, the leakage was small enough to be readily controlled by a small pump, and the pier was built up without further incident. The concrete below water was built in forms, while above water the sandstone facing acted as a form, being backed up with concrete as fast as the stone was set.

The preceding refers to the construction of the first of the two river piers. The same method was used in the following spring for the other pier, as careful levels showed no settlement of the finished work and it was therefore concluded that the deposition of concrete under water to form the footing course was satisfactory. Both piers showed a settlement of about ¾ in. in nine months after construction.

The substructure work involved the following quantities:

| | |
|---|---|
| Stone, cu yd | 6,183 |
| Foundation concrete, cu yd | 4,451 |
| Pier concrete, cu yd | 2,906 |
| Total | 13,540 cu yd. |

## SUPERSTRUCTURE

The trusses of the bridge are of full pin-connected type. This makes the structure unusual among large modern bridges, as the tendency has been toward using pin and rivet joints in a compromise arrangement, or else riveted connections only, in bridges of large size.

LOADS AND STRESSES—The loading for which the trusses were designed was 2000 lb. per lin.ft. of truss for the approach spans, 1600 lb. per lin.ft. of truss for the three cantilever spans, and a wind load of 35 lb. per sq.ft. of exposed surface of both trusses on the unloaded bridge. The floor-system was designed for two 50-ton cars, a 15-ton roller, a 5-ton wagon, or a distributed load-

ing of 100 lb. per sq.ft., in such combination or selection as to give maximum stresses.

The unit-stresses governing the design were: In chord, eyebar and floor members, 24,000 lb. per sq.in. for dead-load and 12,000 for live-load; in stringers, 20,000 and 8000; in posts, 20,000 and 10,000; in bracing, 13,000; in pins, bending, 25,000, etc. In all cases the allowable stress-intensities in compression were the tensile values reduced by a straight-line column formula. The maximum stress from combined dead, live and wind load was limited to 20,000 lb. per sq.in., reduced by compression formulas for struts.

SPECIAL LATTICE—The general design made all compression members of two built channels latticed together.

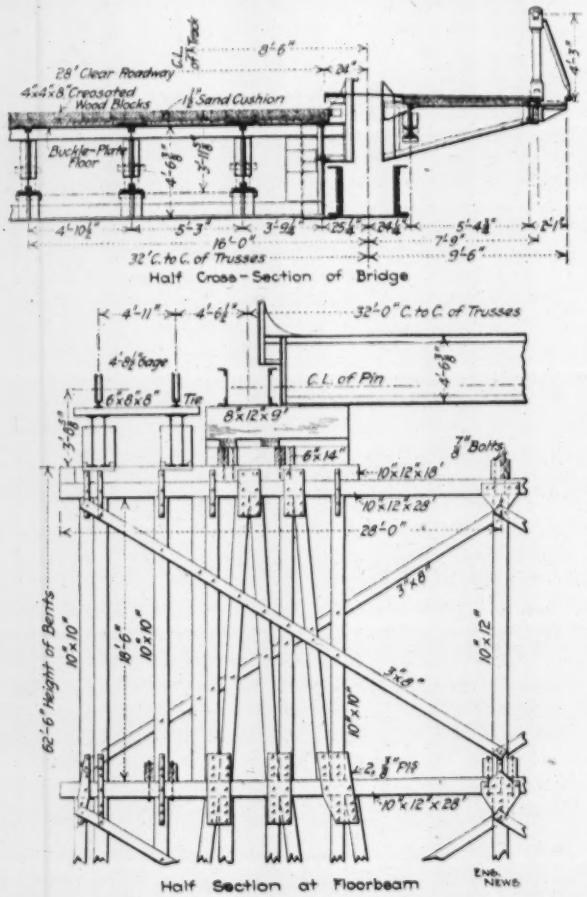



FIG. 4. CROSS-SECTION OF SEWICKLEY BRIDGE AND FALSEWORK

The contractor in checking over the design found it necessary to increase the bottom-chord section considerably in many panels, and as the depth of the chord could not be increased without extensive changes the section was altered to two built I-shaped sections latticed, of the original depth, 28 in. The latticing was at the same time changed from 6-in. channels to flat bars, and in some panels to a special lattice of single angles set with vertex up and flattened at ends and center for riveting. This type of lattice, which is new so far as is known, is shown by sketch in Fig. 2; it was used in 3x3x$\frac{5}{16}$ in. and 3½x3½x$\frac{5}{16}$-in. sizes. Tests of such lattice bars showed an ultimate strength of 23,000 to 26,000 lb. per sq.in., whereas 5-in. and 6-in. channel struts failed at 16,000 to 18,000 lb. per sq.in. This special angle lattice, being placed with the point of the angle up, sheds water perfectly.

LONG RIVETS—The splices in the bottom chord were made a little to one side of the panel-points. The splice-plate sections were proportioned for 50% of the stress in the member. Great thicknesses of metal were reached at the foot of the main post over the main pier and at the anchorage shoe. At the main shoe, rivets of 10¼-in. grip had to be used and, at the same panel-point, around the bearing of the main pin the rivets have 6⅜-in. grip. These are all shop rivets, and no difficulty in driving them tight is reported. A number of field rivets of 5$\frac{5}{16}$-in. grip occur in the structure. These pass through four web-plates and six splice-plates with 18 painted surfaces, and trouble was experienced in getting them tight with pneumatic hammers. A pneumatic grip riveter was then used, and satisfactory results obtained. The size of the connections in this structure is further indicated by the fact that the largest pin is 14 in. in diameter.

ANCHOR-ARM TOP CHORD—An important change was made by the bridge company in redesigning the top chord of the anchor arm. This top chord as originally designed in the county engineer's office consisted of eyebars packed together with a light compression member. Difficulty in getting a satisfactory distribution of stress between the different parts of the member was anticipated by the contractor; also, the member had not sufficient compressive strength to enable the anchor arm to swing clear of its falsework before the erection of the cantilever arm. This meant danger of collapse if a flood should carry away the falsework before the cantilever arm was erected far enough to put tension into the top chord of the anchor arm. The design was therefore changed to make this top chord a rigid member, though still of pin-connected type. The arrangement of the successive panels of the chord offered some difficulty in securing a suitable packing of the members at the joints on the pins, the successive chord sections having to lap past each other to form tension heads. The final design shows the panels alternately narrow and wide, but with the flanges kept at practically the same total width by using angles of different widths of leg.

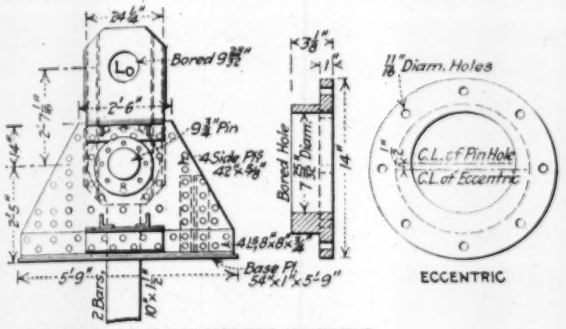
ANCHORAGE DETAILS—The anchorage engages practically the full weight of the anchor pier, by means of a pair of lattice girders bedded in the anchor pier at the foot of the anchor chain, extending the full length of the pier. These girders also help to tie the anchor-pier masonry together, and prevent cracking.

To allow for the stretch of the anchor chains as the load gradually came upon them during the building out of the cantilever arm, the well around the upper part of each anchor chain was left open until the bridge was completed. This stretch had also to be allowed for at the connection of the anchor chain with the shoe, so as to keep the shoe bearing on the pier. Instead of using wedges for this purpose, as was done in the Beaver Bridge,* an eccentric adjustment was employed, which is shown in the drawing Fig. 5. The adjustment is fitted at the lower end of the short rocker which connects the end pin of the bridge with the pin at the shoe. The lat-

*See Engineering News, Jan. 26, 1911, pp. 89-95.

ter is a 9¾-in. pin, taking the lower end of the rocker and the upper end of the anchor eyebars, and also passing through the webs of the shoe. Where passing through these webs, however, the pin is turned down to 7¾ in. and is surrounded by a flanged steel sleeve, whose hole is bored ½ in. eccentric to its outer circumference. This sleeve is seated in the web of the shoe, and when turned in its seat shifts the pin a total amount of 1 in. up or down.

The adjustment of this eccentric was made when the creeper traveler stood at its extreme position, near the middle of the suspended span. The anchorage pull under this loading was almost the same as the maximum load-uplift on the completed bridge. Therefore, when the eccentrics had been turned to bring the end shoes into firm bearing on their beds, the anchorage eyebars were held at maximum stretch, and no looseness or pounding could develop under any load conditions in the future. The eccentrics were retained in their adjusted position



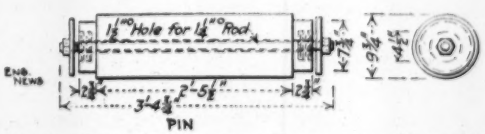




FIG. 5. END SHOE, WITH ECCENTRIC ADJUSTMENT FOR ANCHORAGE

by screws entering tapped holes in the shoe webs, drilled and tapped after the adjustment.

MAIN SHOE—The main shoes, steel-riveted assemblages, designed with three ribs and three diaphragms, receive the 14-in. pins at the base of the main or tower posts. These posts have three webs, joined by latticing. The pin bearing in the three ribs of the shoe is 17¾ in. wide. Each shoe has a base 8x9 ft., is about 8½ ft. high to center of pin, and weighs 37,860 lb.

The two shoes on each pier are connected by a strut 30 in. wide by 4 ft. deep, independent of the cross-bracing of the trusses. The end attachment gussets of the strut also carry the floor-beam over the pier, which arrangement avoids the necessity of attaching this floor-beam to the truss post and carrying the load down through the pin. The problem of making the connections at this panel-point was greatly simplified by thus eliminating the floor-beam connection.

Some of the connections of the web members at the bottom-chord panel-points were simplified by making the forked connection common to two web members. At *LS*, for instance, the connection is shop-riveted to one of the two diagonals and the other diagonal is field-riveted to it at a point 3½ ft. from the pin center. At the foot of the main tower the principal compression diagonals are similarly connected, except that here the connection is a separate erection piece, both diagonals being field-connected to it. The secondary stresses due to such connection were properly allowed for in proportioning the members.

BRACING—The bridge is braced by a full top-lateral system, supplemented by portals in the planes of the end posts and of the principal diagonals leading down to the main pier, and by transverse sway frames at all panel-points. It has no bottom-lateral bracing, however, the buckleplate floor with its stiffening by the stringers and floor-beams being relied upon to take all the wind shear. At the ends the wind reaction must pass down the rockers into the end shoes. The near-by Beaver bridge, with a full bottom-lateral system, has a separate wind abutment with sliding connection, on the middle of the anchor pier, engaging the end of the lateral system.

A sliding connection was required in the Sewickley bridge, however, at the junction of cantilever arm and suspended span. It is made on the middle line of the bridge, by a square sliding block on the end of a triangular lateral frame in the end panel of the suspended span engaging jaw plates on the end of the cantilever arm.

The type of portal and sway bracing used is indicated by the sections in Figs. 2 and 3.

CAMBER PROVISION—The bridge was cambered to come to its theoretical shape under full load. This meant changing the length of each member by an amount equal to its change of length under full load, but in the opposite direction; that is to say, building the compression members longer than their geometric length and the tension members shorter. No difficulties were encountered in bringing members together at joints during erection on account of their departure from geometric length, as there are practically no redundant or excess members in the framework.

The stringers were affected by this camber provision, as their lengths correspond to geometric lengths, while the bottom chords of the truss, being in compression, were built longer than geometric length. The stringers, intended to fit against the webs of the floor-beams and rivet to them, were thus too short until after the bottom chord was under considerable compression. For this reason during erection the stringers were carried on shelf-angles riveted to the floor-beam webs; these shelf-angles were supported by stiffeners proportioned for the erection floor-loads.

ERECTION ADJUSTMENT—For making the adjustment at the ends of the suspended span the bottom-chord wedge device and top-chord toggle which had been used in the Beaver Bridge were borrowed. These devices are shown in Fig. 6. No trouble was experienced in using them. The wedges and toggles were so set prior to beginning the erection of the suspended span that the subsequent motion would only have to be a slacking off and not a drawing up, the latter, of course, requiring much greater power to operate.

It was also necessary to provide adjustment in the center panel of the suspended span. The original design showed crossed diagonal eyebars in this panel without any adjustment. The contractors substituted compression members for the lower halves of these diagonals and adjustable eyebar members for the upper portion, with the

central connection plate riveted to the lower subdiagonal on the side first erected. With this arrangement all parts of the central panel web were readily supported, and the upper adjustable diagonals, which were detailed to be seated outside of the connection plate, were then easily slipped on and tightened up.

### Erection

The anchor arms on both sides of the river were erected on falsework in accordance with ordinary practice. The traveler used for this work was a three-bent outside traveler, specially designed and built for this bridge, but so made as to be capable of use for almost any erection conditions, i.e., with trusses of any spacing and any height, by making the transverse and longitudinal framing and the vertical frames themselves adjustable in length over a large range of dimensions. The floor system of the bridge, as well as the bents of falsework supporting the whole structure were, however, set by a locomotive crane, which proved very advantageous for quick working. At some points it was necessary to distribute the high concentrations of load on the front trucks of the locomotive crane, to prevent overloading the stringer brackets; this was done by taking off the rear counterbalance and supporting the front of the crane by special outriggers, carrying the load to four lines of stringers.

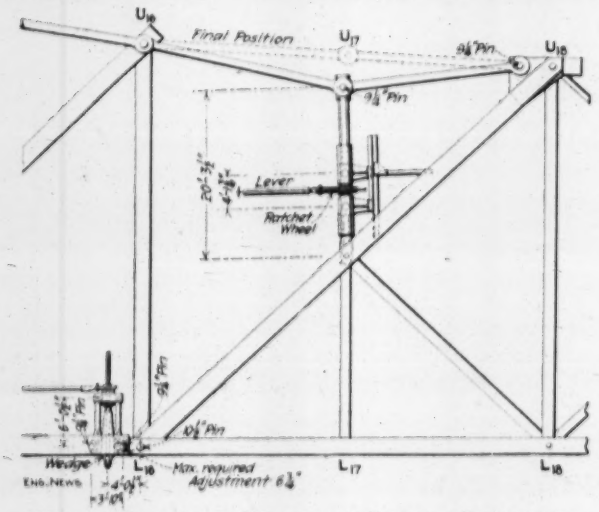



Fig. 6. Adjusting Devices at Ends of Suspended Span

(Designed for Beaver Bridge and first used there.)

The upper parts of the main posts were somewhat higher than the main traveler. They were erected by hoist falls slung from gallows-frame extensions built on top of the traveler and carried on rearward projections of the loading girders which extend along the top of the traveler over the truss locations. This arrangement gave rise to no difficulty.

The original plan was to erect the entire channel span by the cantilever method, setting a top-chord or creeper traveler on the trusses after erecting one panel outside of the main pier, and carrying on the further work with this traveler. The contractor, however, preferred to erect the cantilever arm with the main traveler. As the truss details were not strong enough to carry the main traveler, he secured permission from the government for extending falsework out to the ends of the cantilever arms, on one side of the channel at a time so as to leave a clear width of at least 500 ft. The main traveler, therefore, erected the bridge out to the end of the cantilever arm on either side, running on this falsework, and finally assembled the creeper traveler on the top chord for erecting the half of the suspended span; then the falsework was pulled and taken to the other side, and driven there for the erection of the other cantilever arm.

To avoid any chance of overloading this falsework by concentration of the weight of the cantilever arm, which deflected progressively as the erection went forward, the trusses were kept free of the falsework except for the panel in course of erection. This subject required careful attention, as the outer end of the cantilever arm with the traveler at that point had a deflection of about 10 in. below its unstrained position.

As the traveler was carried by the falsework at all times, in case of damage to the falsework by ice or high water there would have been great risk of loss. Therefore the effect of carrying the traveler lashed to the cantilever arm, after knocking out the blocking under the traveler so as to leave the falsework free, was investigated. It was found that the structure would be safe

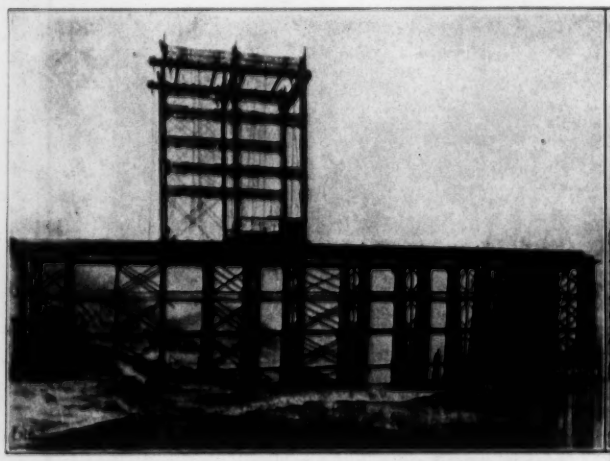


Fig. 7. Sewickley Bridge; Falsework for Anchor Arm, and Gantry Traveler

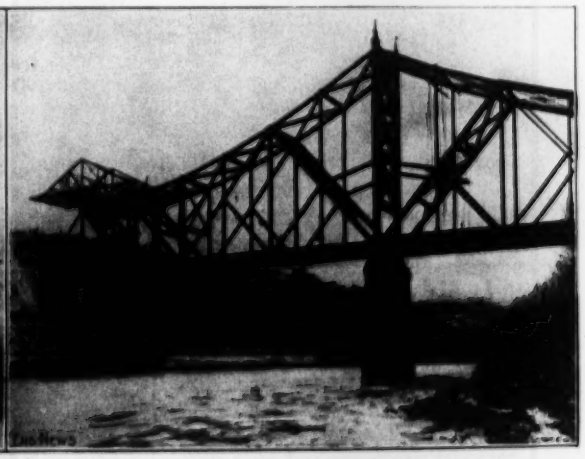
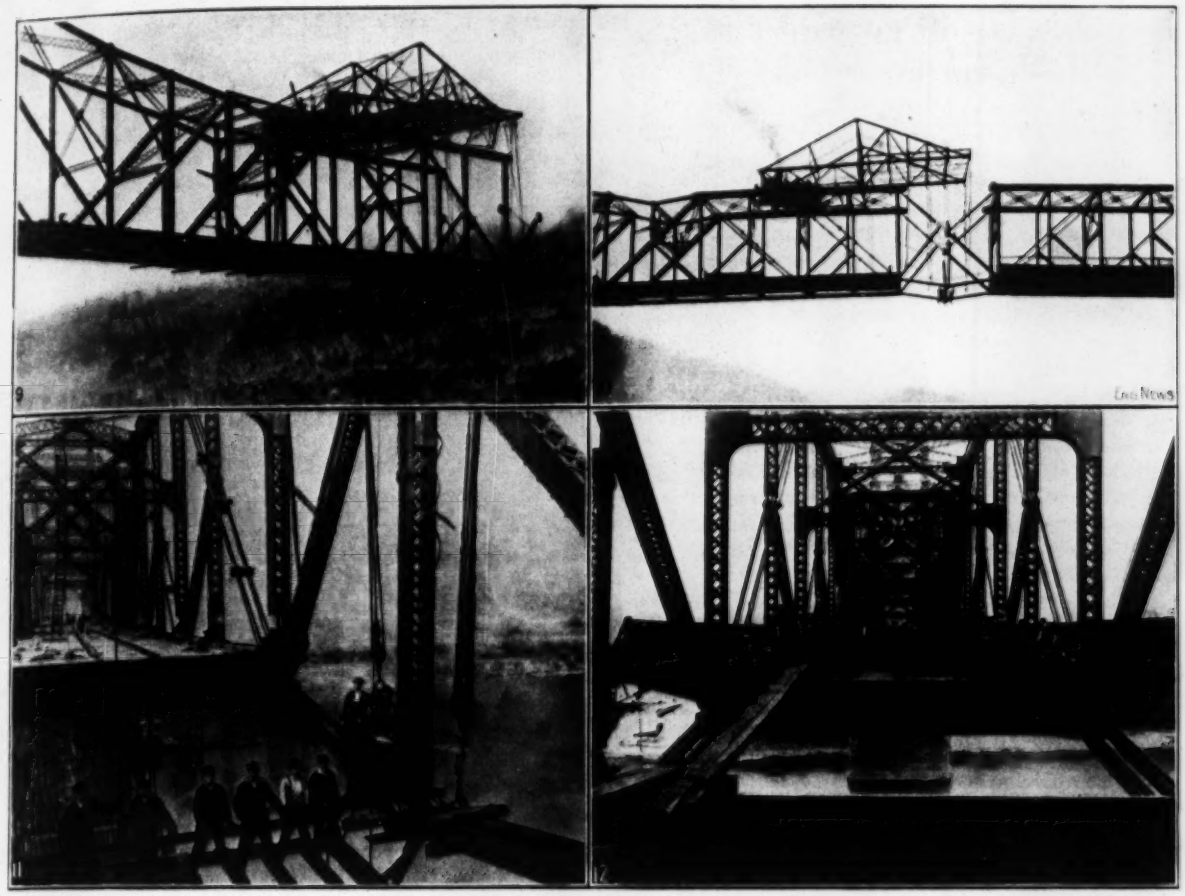


Fig. 8. Creeper Traveler on End of Cantilever to Begin Erection of Suspended Span



FIGS. 9 TO 12. ERECTION OF SUSPENDED SPAN, AND CLOSURE.

FIG. 9. ERECTION IN PROGRESS, MAR. 21, 1911.
FIG. 10. CLOSING BOTTOM CHORD, MAY 15, 1911.
FIG. 11. DRIVING CENTER PIN IN BOTTOM CHORD, MAY 15, 1911.
FIG. 12. MIDDLE FLOORBEAM IN PLACE, ADJUSTMENT NOT YET MADE, MAY 16, 1911.

under these conditions except after the erection of the creeper traveler, under which condition the structure would be over-stressed. The working schedule was laid out so that the assembling of the creeper traveler would be done in a season when there is no danger of high-water or ice trouble. No conditions occurred at any time to endanger the cantilever falsework, though the anchor-arm falsework went through some critical periods.

The erection of the Sewickley bridge was completed during 1911, the suspended span having been closed on May 16, 1911.

The weights of the principal elements of the bridge are given in the following table:

WEIGHTS OF STEEL, SEWICKLEY BRIDGE

| | Shapes and Plates lb. | Eyebars lb. | Buckle-plates lb. | Total lb. |
|---|---|---|---|---|
| Approach spans | 1,029,704 | | 210,475 | 1,240,179 |
| Anchorages | 72,646 | 20,600 | | 93,246 |
| Anchor arms (incl. tower posts) | 3,717,741 | 464,560 | 247,965 | 4,430,266 |
| Cantilever arms | 1,849,693 | 533,150 | 162,725 | 2,545,568 |
| Suspended span | 1,454,230 | 204,405 | 146,445 | 1,805,080 |
| | 8,124,014 | 1,222,715 | 767,610 | 10,114,339 |
| | | | Railing | 300,461 |
| | | | Total | 10,414,800 |

The cost of the bridge is as follows:

| | |
|---|---|
| Substructure, incl. filling and paving | $120,293.84 |
| Superstructure | 398,966.83 |
| Street-car rails | 18,178.00 |
| Total | $537,438.67 |

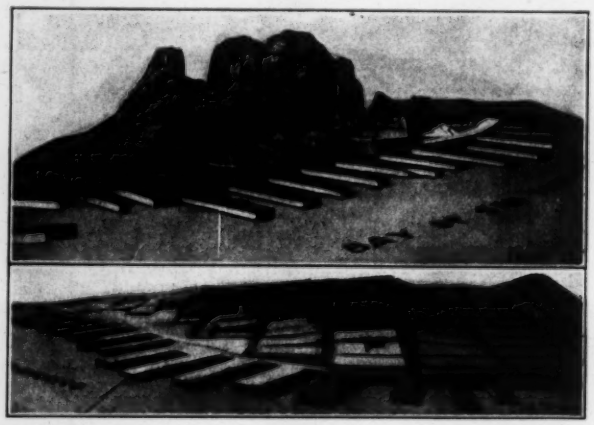
The bridge was designed by J. G. Chalfant, County Engineer of Allegheny County, and G. Gudmundsson, Consulting Engineer. A. W. Buel, Consulting Engineer, was retained by the Fort Pitt Bridge Works to take charge of revision of the design, detailing and design of the travelers; besides carrying out this work he also acted in consulting capacity during erection. H. R. Blickle is Chief Engineer of the Fort Pitt Bridge Works.

**Mineral Production of the United States** in 1912, promises to show record-breaking figures, according to a recent press bulletin of the U. S. Geological Survey. In addition to the coal production of 550,000,000 tons (noted in "Engineering News," Jan. 9, 1913, p. 90), there is an estimated production of refined copper of 1,560,000,000 lb. compared with 1,434,000,000 for 1911; the Arizona production is expected to exceed 350,000,000 lb., a record for that or any other state. In the gold-mining industry, the smallest production since 1907 is estimated; for 1912 the value is expected to be $91,685,000. In silver production an output of 65,000,000 oz. is indicated, the highest figure since 1892; the average price of silver in the year was 60.9c. per oz. Preliminary figures for lead show a small decline from the high-record figures of 1912, the total output of refined, desilverized and soft lead from foreign and domestic ore being 480,965 short tons valued at $43,286,850. The domestic production was 20,000 tons greater than in 1911—441,190 short tons. Of zinc, 324,000 tons are reported from domestic ores and 14,700 tons from foreign ores, a total of 338,700 tons valued at $46,731,000 compared with 287,000 tons in 1911. The production of iron ore promises to be some 30% greater than in 1911, being about 57,000,000 long tons—a possible record figure.

## A Project for Regrading Rincon Hill, San Francisco, Calif.

The city of San Francisco has been provided by nature with a reasonably good harbor, but with relatively meager land facilities for access to docks and for associated industrial districts. To make up in large measure for this deficiency a scheme is on foot to regrade a jagged elevation near the water front, known as Rincon Hill. To prepare the way for necessary action by the city the scheme has been studied in much detail for some months past by the engineering department of the San Francisco Chamber of Commerce and, as regards property values and financing generally, by a committee of the Associated Savings Banks of San Francisco. John S. Drum is chairman of this committee and he is also a director of the Chamber of Commerce. The engineering estimates have been made by A. H. Campbell, engineer in charge of the Inspection Bureau of the Chamber of Commerce. (The Bureau inspects all city work paid for from the proceeds of bond issues.)

An account of this interesting project, with Mr. Campbell's estimates in some detail, is published in the *Journal* of the Chamber for January, 1913. The *Journal* states that it proposed to remove or lower Rincon Hill in order that "San Francisco may have a defined and well



MODELS OF RINCON HILL, SAN FRANCISCO, CALIF., AS NOW APPEARING AND AS PROPOSED AFTER REGRADING

(The upper view is assumed looking northwest and the lower one looking southwest).

equipped industrial district and easy access to the new docks south of Harrison St."

We reproduce from the *Journal* views of models of Rincon Hill now and as it would appear "after regrading had turned it into a choice warehouse and factory" district, with grades "practical for railway spurs and heavy teaming."

Of the alternative grading plans under consideration the execution of one is estimated to cost $4,786,000, and of the other, $5,267,000. Either plan would involve about 1,000,000 cu.yd. of street excavation which, with repavement and other street and sewer work, would cost about $1,500,000. The volume of material to be removed from private property in the regrading is not stated, but the estimated cost of this work is $3,282,000 under the less and $3,557,000 under the more expensive plan. The estimated present value of the 18 blocks of private property embraced in the more expensive regrading plan is $8,818,000, or an average of $2 per sq.ft. This estimate assumes the market value of the land at twice its assessed valuation. If the street grades were reduced to 2%, it is estimated that this land would be worth at least $3.50 per sq.ft., making a gain of about $6,700,000. The scheme seems to be to meet the cost of regrading by assessments for benefits distributed over a large assessment area. The *Chamber of Commerce Journal* quotes M. M. O'Shaughnessy, City Engineer of San Francisco, as saying:

> This Rincon Hill property is focally located between the new docks and the warehouse district. If it were graded it would be worth from $400 to $500 a front foot. Its present value is not much more than $125 a front foot. There is rock foundation throughout the entire area and no piling would be necessary for the construction of the largest buildings.

⁂

## City Planning*

It is gratifying to note the continued interest and the growing appreciation of the value of town planning. During the past year many cities in the United States and Canada have turned their attention to the subject. Some are taking active steps to improve their water fronts, solve railroad problems or to plan civic centers. Others are turning their attention to suburban development and in a few more ambitious instances comprehensive plans are being prepared for the growth and development of the entire city.

The activity in the various societies and civic bodies continues, and lectures on city planning and meetings devoted to the subject are on the increase. The result of these activities has been to interest the city authorities themselves and it is encouraging to note that in numerous cases the local city governments have espoused the idea, and, recognizing the value of technical advice, have appointed expert advisors to guide them in the development of their cities.

It was the thought of your Committee that we could perform a service to the members of the American Institute of Architects by suggesting some general ideas that might serve as a guide for municipalities in the preparation of their plans and in the adoption of the necessary legislation. The authorities as a rule are somewhat at a loss to know how to proceed and the first steps are the most difficult.

Much interest has been shown in the Town Planning Act [1909] now in force in England and it seemed possible that this act or a modification of it might serve as a basis for a similar law that would be suitable to American cities. After consideration, however, this did not appear feasible. The English Town Planning Act provides for a central body possessing absolute power which can criticize and control the plans of all English cities which must be presented to it for its approval†. This does not appear to be possible in our country. The laws in each state are different and each town planning act would necessarily have to be drawn to conform to the state law. Lately a very strong movement in favor

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*Report of Committee on Town Planning, as read before the American Institute of Architects, Washington, D. C., December, 1912. The report will be published in full in the Journal of the Institute. The Committee was composed as follows: Messrs. Arnold W. Brunner, Chairman; W. R. B. Wilcox, C. L. Borie, Jr., J. R. Coolidge, Jr. and Glenn Brown.

†This statement and the remainder of the paragraph seem likely to mislead those unfamiliar with the scope of the Town Planning Act and the way it is being administered by the Local Government Board. The act grants municipalities large new powers over the laying out of undeveloped areas, but instead of going into minute details, as is done in our own state legislation, it entrusts the formulation of details of procedure to the Local Government Board, whose approval must also be secured before any plan can be adopted. The act, at least so far as yet applied, relates to the laying out of undeveloped areas. Of course central control over town planning would lie in the several states, under our plan of government. Such control would be no more a violation of municipal home rule than is the control now exercised by a number of our state boards of health, state water-supply commissions, the Massachusetts Gas and Electric Commission and some of our public service commissions over public water-supplies, sewage disposal, and gas and electric light plants. Central administrative control substitutes for shifting legislative control and interference the jurisdiction of a relatively permanent body, provided with a staff of technically trained men. So far as city planning goes, most of our American cities, far from possessing home rule powers to deal with the subject, have no powers whatever; and when they want such power or any change in even minor details of it, they must run to the legislature.—Ed. Eng. News.

of what is called "home rule" for cities has manifested itself so that a general state law governing the powers of a city to make its plans would, we think, be very unpopular. The conditions, not only in different states, but in different cities, vary so greatly that we believe it would not be well to attempt to frame a general law.

The regulations that obtain in France and in Germany seem entirely inapplicable to our form of government and apparently it is advisable for our cities to make their own rules and regulations.

It has been found to be extremely difficult to obtain documents and pictures that relate to city planning and there is a constant demand for such data. We suggest that the American Institute of Architects enlarge its present collection of lantern slides and procure views of the best examples in Europe and America. Many pictures can be obtained showing suburban development and garden cities, also views of civic centers, street intersections, settings for buildings, water fronts, railroad terminals and similar subjects illustrating problems connected with city planning. These might be loaned to the members of the Institute to assist them in their work, or copies might be made at a nominal cost and sold to those interested.

It is most desirable that some central library should collect plans of important cities, properly drawn to scale, and there is much detailed information that is constantly required. Undoubtedly the possession of this library would be of great value to our members and it seems to your committee that the American Institute of Architects should take immediate steps to collect maps and documents which would form the nucleus of such a library. We believe that the cost might be met by private subscription. The value of this can hardly be overestimated. The cost of additional lantern slides is easily within our means and would be a very great service to members who wish to deliver lectures on city planning, but we strongly urge the foundation of a real reference library on city planning.

## Classified Salary and Wage Budget Estimates of Chicago for 1913*

Appropriations made for salary and wages of employees in the service of the city of Chicago, exclusive of the employees in the park boards, the sanitary district and Cook County, amount to an aggregate of $28,782,699 for the year 1913. This appropriation will care for approximately 22,825 employees, of whom 14,935 are under the municipal city service.

The details of the 1913 City Budget have just been prepared by the Efficiency Division of the Civil Service Commission as the result of a comprehensive analysis of the employment conditions in the city of Chicago. This analysis shows that the compensation and distribution of positions in the city service are as follows:

| Service | No. of Employees | Total salaries | Average salary | % of total |
|---|---|---|---|---|
| Medical | 347 | $ 347,925 | $1003 | 1.2 |
| Engineering | 352 | 647,819 | 1843 | 2.3 |
| Clerical | 1,146 | 1,400,365 | 1222 | 4.9 |
| Police | 4,482 | 5,921,935 | 1323 | 20.5 |
| Operating Engineering | 576 | 1,283,284 | 1274 | 4.4 |
| Fire | 1,893 | 2,718,641 | 1436 | 9.4 |
| Library | 149 | 141,350 | 954 | 0.5 |
| Inspection | 728 | 945,705 | 1401 | 3.3 |
| Supervising | 320 | 398,558 | 1383 | 1.4 |
| Skilled labor | 2,267 | 2,594,960 | | 9.0 |
| Labor | 2,676 | 1,920,881 | | 6.7 |
| Educational | 7,229 | 8,360,685 | | 29.0 |
| Law and municipal courts | 525 | 999,560 | | 3.5 |
| Administrative | 137 | 456,371 | | 1.6 |
| Blanket appropriation—emergencies | | 662,660 | | 2.3 |
| | 22,825 | 28,782,699 | 1261 | 100 |

Because of the stringency in funds, occasioned by the new interpretation of the Juul Law by the Supreme Court, only 80% of the above amounts are being paid to the employees. This will continue until such time as relief is obtained from the legislature.

According to the functions of different departments, the city is employing and expending for services the following:

| | No. of employees | Total salary | Per cent. |
|---|---|---|---|
| Safety of public and property | 7,771 | $10,298,131 | 35.8 |
| Service, public works and improvements | 5,103 | 5,668,246 | 19.6 |
| Public betterments | 8,750 | 10,749,980 | 37.4 |
| Financial purposes | 365 | 577,469 | 2.0 |
| For legal service and administration of justice | 525 | 1,008,091 | 3.5 |
| For administration and legislation | 281 | 480,785 | 1.7 |
| | 22,825 | 28,782,699 | 100 |

The total appropriations for 1913 for all purposes and services by departments are given in the following:

| | | |
|---|---|---|
| Board of Education | $18,941,250 | 28.6% |
| Department of Public Works | 17,062,840 | 25.8% |
| Department of Police | 8,968,944 | 13.5% |
| Department of Finance, Comptroller's Office | 5,534,509 | 8.4% |
| Fire Department | 5,093,313 | 7.7% |
| Department of Electricity | 1,730,254 | 2.6% |
| Chicago Public Library | 1,351,640 | 2.0% |
| Harbor and Subway Commission | 1,198,470 | 1.8% |
| Department of Health | 1,120,851 | 1.7% |
| Miscellaneous | 5,196,477 | 7.9% |

Distributions of total appropriations for all needs and services according to functions of the city government are as follows:

| | | |
|---|---|---|
| Public betterments | $21,476,487 | 32.4% |
| Service public works and improvements | 20,086,954 | 30.4% |
| Safety of public and property | 16,437,916 | 24.9% |
| Finance | 6,059,074 | 9.1% |
| Legal | 1,287,601 | 1.9% |
| Administration and properties | 850,479 | 1.3% |

The above amounts include the moneys appropriated from the corporate-purposes fund, the water fund, the bridge-bond fund, traction deposits, the sinking fund, public-library fund, Municipal Tuberculosis Sanitarium fund, school fund and funds contingent upon sale of bonds during 1913.

Diagrammatic charts have been drawn which give a pictorial and vivid display of the physical conditions of organization, compensation, class of work, and responsibilities of all positions in the city service. In addition to these, the physical detail is accompanied with all the civil-service data necessary to make the chart a complete analysis of the annual budget, both as to number of employees and the salary items in each department of the city service. The entire plan is one of scientific analysis of the public service. [See ENG. NEWS, May 2, 1912, pp. 834-5, for similar charts for 1912 and for a more detailed statement of classified positions and average salaries than are here given.—ED.]

These distribution and compensation charts serve two great functions; the first, for administrative purposes, and the second, for educational purposes.

This is the third analysis of the employment conditions of the city government and the charts show continued improvement in the classification, standardization and equalization of compensation of all positions in the city service. By this analysis it has been possible to compare the compensation of positions of similar duties.

The citizen who studies the entries on the charts and who notes the way in which each position is classified and labeled according to its general duties, and how it is measured and graded according to its importance, responsibility and authority, will see the close relationship existing between the organization of departments and the functions performed by the Civil Service Commission.

*Condensed from a press statement sent to this journal by J. L. Jacobs, Efficiency Engineer, Chicago Civil Service Commission.

**U. S. Army Aviators** are to receive 20% increase in pay while engaged in this work as compensation for the added hazard of the occupation. As introduced in the House, the bill for this gave an increased compensation of 100%, but the Senate held that it was unnecessary to pay so much as there were plenty of volunteers.

# Street Cleaning Efficiency Standards for Chicago

By F. H. Cenfield and A. B. Segur*

*SYNOPSIS—A detailed analytical study of street-cleaning conditions and methods in Chicago was made in 1912 by the Efficiency Division of the local Civil Service Commission. Standards based on these studies have been formulated to govern frequencies of cleaning on different classes of streets and also the standard unit amount of cleaning to be expected from each cleaner for different paved surfaces.*

The Civil Service Commission of Chicago, acting under instruction from the City Council, made an investigation of street and alley cleaning and of refuse collection and removal in Chicago (see this journal for Jan. 16, 1913, for an account of the latter). These activities are performed under the direction and supervision of the Bureau of Streets, Department of Public Works, and are carried on separately for each of the 35 wards of the city.

All available records concerning the kind, age and physical condition of pavements in Chicago were examined by the Commission. Records of costs of street cleaning as recorded for the city were of little value, due to recent changes in ward boundaries. This necessitated a complete study of all conditions affecting street cleaning.

The lack of a uniform system of records and cost figuring for the various cities of this country and of Europe made it impossible to use the costs of other cities as a basis of comparison. Investigation conducted by the United States Bureau of the Census indicates that the unit cost of street cleaning in cities under 300,000 population was considerably less than in cities of over 300,000. A study of methods used and efficiency of labor would lead to the opposite conclusion.

Street-cleaning work, as performed in the various sections in the City of Chicago, is intended to cover all paved streets and alleys and consists of (1) cleaning streets by hand with brooms, (2) patrolling streets with boulevard scrapers, (3) cleaning streets and alleys by gangs of men equipped with necessary tools, (4) flushing streets with machine flushers, (5) cleaning streets with machine sweepers.

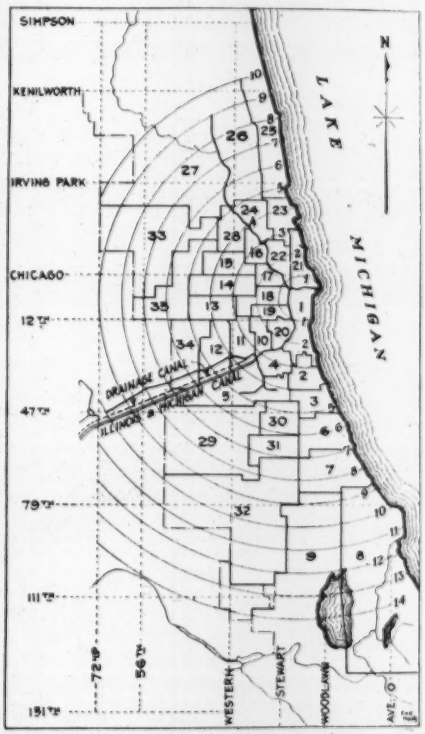
The methods employed by the various wards are generally the same, varying somewhat with the character of pavement. In most cases the streets are cleaned by hand under the block or patrol system. The street dirt is collected by the sweeper in push-carts of 12 cu.ft. capacity and dumped onto vacant lots or in unused alleys, where it is picked up by dirt wagons and carted to the dumps. All work within a ward is under the direct supervision of a ward superintendent who reports to the second assistant superintendent of streets.

The organization maintained by each ward superintendent is as follows: street sweepers are assigned to particular blocks or sections of streets and work under the direct supervision of a sub-foreman, who in turn reports daily the time of sweepers and general condition of his district to the ward superintendent.

The dirt which collects upon the streets of a city is derived from a number of different sources, the principal ones of which are as follows:

(1) Excrement of animals.
(2) Material lost by passing vehicles.
(3) Dirt swept from sidewalks and thrown from buildings onto the street.
(4) Dirt from unpaved streets and alleys.
(5) Falling leaves.
(6) Building construction.
(7) Soot and dust from the air.
(8) Material originating from the wear of pavements.

The amount of street dirt which is directly attributed to horse-drawn vehicle traffic is apparent from George A. Soper's statement "that on an average 1000 horses will excrete 500 gal. of urine and ten tons of dung during a working day of eight hours." This is by far the most important source of street dirt and has been given the




Population Density Map of Chicago Used in Studies to Establish Street-cleaning Efficiency Standards

greatest weight in the preparation of the schedules and standards used as a basis for the estimates of future expenditures.

It has been found that, except in very rare instances, the amount of cleaning which any street requires, other things being equal, is directly proportional to the density of horse-drawn vehicles upon the street.

The difficulties which lay in the way of this conclusion arose from various sources, as follows:

First: It was found that there was no standard in the city for street cleaning; that the appropriations marked the limit of expenditures; that in arranging street-cleaning schedules, various residence streets which had a very light traffic were given cleaning daily chiefly because they chanced to lie close to some other street which called for

*Engineers, Efficiency Division, Chicago Civil Service Commission, Chicago, Ill.

daily cleaning. Many people in the outlying wards desired the same service that was given within the shopping district, and in making statements to the Commission, gave their opinions upon that basis.

Second: The importance of the character of traffic, whether the wagons were heavily or lightly loaded, was greatly overestimated and details which have been proven by this investigation to be of comparatively small value were greatly magnified; that is, upon a careful tabulation to determine the importance of these factors, it was learned that some of them gave negative results.

A traffic census conducted on 500 different sections of streets in the city revealed the following:

That the number of three-horse and four-horse vehicles within any ward was almost negligible in comparison with the number of one-horse and two-horse vehicles.

That the variation in the ratio of one-horse vehicles to two-horse vehicles in various wards of the city was very small and that for all practical purposes all horse-drawn vehicles could be grouped together to form one arbitrary unit. This immediately simplified the matter of a standard.

Third: The absurd view that many held of the importance of the width of street upon the cleaning which the street should receive. It was learned, however, that the main importance of the width of the street lay in determining the density of traffic upon the street, and if the number of horse-drawn vehicles were divided by the product of the width of street and the times cleaned per week, a constant was obtained which was a standard of the cleanliness of the ward. While these cleanliness ratios were not always constant throughout a ward, still it was noted that over all main thoroughfares in any ward these ratios were practically a constant and that in wards having substantially the same street conditions, the average ward ratios were the same. In other words

$$C = \frac{E}{NW}$$

$N$ = number of times a street is cleaned per week.
$E$ = total number of horse drawn vehicles in 8-hour day.
$W$ = width of street in feet.
$C$ = constant of cleaning.

It has also been noted that as conditions exist in Chicago, it is important that the streets in the heart of the city be kept cleaner than the streets in the outlying districts, as it is the cleanliness within the heart of the city that fixes the reputation of the community. For this reason all of the wards (see accompanying map) have been divided into two classes, as follows:

Inlying wards, 1, 2, 3, 4, 5, 10, 16, 17, 18, 19, 20, 21, 22.

Outlying wards, 6, 7, 11, 12, 13, 14, 15, 23, 24, 25, 28, 30, 31, 8, 9, 26, 27, 29, 32, 33, 34, 35.

Tabulation of traffic density, street-cleaning schedules and conditions gave the following average constants:

| Character of street | Inlying wards | Outlying wards |
|---|---|---|
| Business streets (or manufacturing) | 2.6 | 2.8 |
| Residence streets | 2.1 | 2.5 |

It is apparent that there are limits to the application of the above constants. On many residence streets the traffic is so light that a strict application of the constant would give absurd results. Car-track streets require a definite amount of cleaning regardless of other traffic. The streets around churches, schools, hospitals, playgrounds and other general public institutions require a certain amount of attention irrespective of ordinary team traffic. The following standards have therefore been made for a minimum cleaning of streets, regardless of traffic:

MINIMUM CLEANINGS PER WEEK ON HARD PAVEMENTS, STREETS WITH LIGHT TRAFFIC

| Position of ward | Cleanings per week |
|---|---|
| Inlying | 0.7 |
| Outlying | 0.5 |

MINIMUM CLEANINGS PER WEEK ON CAR TRACK STREETS WITH LIGHT TEAM TRAFFIC

| Position of wards | Cleanings per week | | |
|---|---|---|---|
| | X head room | Y head room | Z head room |
| Inlying | 5 | 4 | 3 |
| Outlying | 4 | 3 | 2 |

X head room—0 to 3 min.
Y head room—3 to 10 min.
Z head room—10 min. or above.

Head room as used is the average time between cars during the rush hour of the day.

MINIMUM CLEANINGS PER WEEK WHERE THERE ARE PUBLIC BUILDINGS

| Churches | Schools | Hospitals and general public institutionss |
|---|---|---|
| Large—3 | Large—6 | Large—6 |
| Medium—2 | Medium—5 | Medium—4 |
| Small—1 | Small—4 | Small—2 |

In cases where the pavement of streets surrounding the foregoing is macadam, the minimum number of cleanings shall be at least one-twelfth of that for hard pavements.

In studying macadam and cedar block pavements, it has been noted that there were various standards in different parts of the city for cleaning macadam pavements and that the number of times macadam is cleaned varies from twice per year in the outlying wards to four times per year in the inlying wards. Several of the wards which had more than ample appropriations gave much better service on macadam, but as an average the following results were obtained:

CLEANING OF MACADAM AND CEDAR BLOCK PAVEMENTS

| Position of ward | | Cleanings per year |
|---|---|---|
| Inlying | | 4 |
| Intermediate | | 3 |
| Outlying | | 2 |
| Inlying | (same as above) | |
| Intermediate | 6, 7, 11, 12, 13, 14, 15, 23, 24, 25, 28, 30, 31. | |
| Outlying | 26, 27, 29, 32, 33, 34, 35. | |

It is not believed that this standard of cleaning will give perfect results, but this standard will give uniform results throughout the city and will give the best results the finances of the city will allow at the present time. In order to obtain street-cleaning appropriations according to these standards, every street in Chicago has been classified according to kind of pavement, condition of pavement, car track, street-car head room, percentage of business and residence, length, width and traffic, and from these tabulations appropriation estimates have been determined.

One difficulty which arose in obtaining standard areas of pavement a man should clean in one day was the faulty opinion that many held as to the amount of time lost in dodging traffic on heavy traffic streets. To determine what this time loss was and to obtain a standard for street cleaning, careful stop-watch observations were made upon various streets of the city, both upon first-class men and upon average men. The results of these stop-watch observations showed that the time lost in necessarily dodging traffic seldom exceeds 3% of the total time. This result is a great deal more reasonable than would appear at first sight. A good street sweeper always watches the traffic and governs himself accordingly and when an automobile, a street car or a wagon approaches, he simply steps to one side and continues sweeping. Not all sweepers do this, and many in the city's employ lose as much as

20% to 30% of their time avoiding traffic, but in practically every case where this was found, it could be directly attributed to loafing and men who lost an excessive amount of time dodging traffic, also lost an excessive amount of time in unnecessary operations.

Stop-watch observations showed that it was possible for a man to cover 34,000 sq.yd. of asphalt pavement in good condition in one working day of eight hours. One sweeper, during a stop-watch observation extending over three hours, was observed to clean an average of 78 sq.yd. of asphalt pavement per minute on a heavy traffic street under an elevated railway, or an equivalent of 37,440 sq.yd. of pavement per day. The pavement, in order to receive perfect cleaning, should have received 10% more attention than was given it, and the number of square yards was, therefore, reduced 10%.

A man to work to 100% efficiency under present conditions should therefore cover 34,000 sq.yd. of asphalt pavement in a working day of eight hours. An average of the schedules of various ward superintendents shows that at the present time the street cleaners are cleaning about 21,100 sq.yd. of pavement per eight-hour day. It was assumed, however, that if sweepers were given a standard amount of pavement to keep clean and given a standard number of times to cover the pavement each day that the city should expect at least 63% efficiency from their street sweepers, and an assumed standard was adopted for this appropriation of 21,500 sq.yd. of asphalt per day. It is not believed that this standard is excessive, as it is being exceeded in a great many instances in different sections of the city by very ordinary sweepers, while there are a few instances where sweepers are performing 50% more work.

After making a careful study of the cleaning schedules in the city of Chicago, and after investigating the results obtained in other cities, it was determined that brick was 35% harder to clean than asphalt, or in other words, to obtain the amount of brick pavement which a man should be expected to clean in an eight-hour day, it is necessary to divide the amount of asphalt that a man can clean in a day by 1.35. Using a standard of 63% efficiency, this gives 16,000 sq.yd. per day as a standard for brick in first-class condition.

A like study showed that granite was 60% harder to clean than asphalt, or in other words, a man should be expected to clean 13,400 sq.yd. per working day of eight hours.

A careful study of various wards of the city showed that pavement in fair condition was 10% and pavement in bad condition was 20% harder to clean than pavement in good condition. The following table has, therefore, been deduced:

| Material | Condition | Standard | Equivalent sq.yd. |
|---|---|---|---|
| Asphalt | | 100% efficiency | 34,000 |
| Asphalt | | 63% standard | 21,500 |
| Asphalt | Fair | 90% of good asphalt | 19,300 |
| Asphalt | Bad | 80% of good asphalt | 17,200 |
| Creosote block | Good | Good asphalt | 21,500 |
| Brick | Good | Asphalt + 1.35 | 16,000 |
| Brick | Fair | 90% of good brick | 14,400 |
| Brick | Poor | 80% of good brick | 12,800 |
| Granite | Good | Asphalt + 1.6 | 13,400 |
| Granite | Fair | 90% of good granite | 12,100 |
| Granite | Poor | 80% of good granite | 10,700 |

Investigations of conditions on various street-car streets and careful time studies indicated that the pavement between car tracks, all other conditions being equal, was 30% harder to clean than pavement outside of car tracks of the same material. It, therefore, became a very simple matter to determine the cost of cleaning car tracks, as 30% was added to the area between the tracks and the cost of cleaning computed according to the standards given above.

In arriving at a standard for the cleaning of macadam pavements for the first cleaning in the spring of the year, the daily reports of the gang cleaners were studied over the months of March, April and May for the following wards: the 6th, 7th, 26th, 27th and 9th. These wards have perhaps the largest percentage of macadam pavement in the city and have the most varied conditions. Constants obtained by the use of these wards are applicable to all the wards in the city. A careful study of the daily reports leads to the conclusions stated below.

In estimating the amount of money required for the cleaning of macadam pavements, the following divisions have been made and the following standards used:

COST OF LABOR REQUIRED FOR CLEANING MACADAM IN SPRING

| Macadam good | | Macadam fair | | Macadam poor | |
|---|---|---|---|---|---|
| Heavy traffic | Light traffic | Heavy traffic | Light traffic | Heavy traffic | Light traffic |
| $1.05 | $0.80 | $1.75 | $1.30 | $2.00 | $1.50 |

A sum equal to 400 teams and autos has been taken as the division between heavy and light traffic for macadam pavement—that is to say, wherever the total number of teams and autos passing in an eight-hour day is less than 400 vehicles, the street will be termed as light traffic; wherever the number of teams and autos exceeds 400, the traffic will be termed as heavy.

The investigation described above was made by the Chicago Civil Service Commission, under the direction of Major James Miles, examiner in charge of the Efficiency Division, and J. L. Jacobs, engineer in charge, and F. H. Cenfield and A. B. Segur, engineers of the Efficiency Division.

## Street Cleaning Costs at Spokane, Wash., in 1912

By S. A. Levington*

As the result of a unit-cost system installed in the Department of Public Works of Spokane, Wash., by D. C. Coates, commissioner, and A. W. Swenson, superintendent of public works, the accompanying actual costs of street cleaning for the calendar year 1912 are available.

The figures given show the actual cost of cleaning, including all incidental items. We have endeavored to keep these data in such shape that the actual cost of each operation can be arrived at and so that such items of expense as are provided for under separate appropriations can be noted.

The use of flushers for only 5½ months was due to the fact that in this climate the weather is not favorable for this method of cleaning for any greater length of time. Our data show that we operated flushers cheaper than the other methods of cleaning and we are very much in favor of this method, as it is undoubtedly the ideal method of cleaning streets.

A gasoline-power sweeper was tried as an experiment and the cost of actual cleaning was found to be far below the cost of other methods of cleaning, but as this machine had not been brought to perfection, the cost of repairs amounted to more than the actual cleaning.

*Cost Accountant, Department of Public Works, Spokane, Wash.

Our system of arriving at cost and number of yards cleaned is as follows: Each street-cleaning sub-foreman is provided with a printed daily-report form and is obliged to turn in at the end of each day this report properly filled out. The report shows the hours worked, names of laborers, hired teams and the number of streets cleaned; it also gives the names of streets cleaned, together with the intersecting streets at which the cleaner started and finished. From this report the cost is figured and the yardage computed from a book, compiled by the engineer's office, showing the number of yards on every paved street in the city, from intersecting street to intersecting street.*

All tools and equipment are taken care of at the city yards and the cost of repairs, labor and material, is reported by the yard foreman in charge of this work.

The charge of $1.50 per day for use of city teams is the actual cost per day for feed, stable care and blacksmith work on two horses.

The charge of $7 per day for use of auto-truck includes gasoline, repairs and depreciation. This truck is owned by the Department of Public Works, but when not in use for street-cleaning purposes it is rented to other divisions at the above rate, plus the wages of driver and helpers.

### COST OF STREET CLEANING, SPOKANE, WASH., FOR THE YEAR 1912

TOTAL AREAS CLEANED AND DIRT REMOVED:

| | |
|---|---|
| Cleaned by sweepers and flushers | 1,283,713 sq.yd. |
| Cleaned by white wings (hand cleaning) | 206,008 sq.yd. |
| Grand total | 1,489,721 sq.yd. |
| Cleaned by sweepers 6¼ months | 1,283,713 sq.yd. |
| Cleaned by sweepers 5¼ months | 477,584 sq.yd. |
| Cleaned by flushers 5¼ months | 806,129 sq.yd. |
| Dirt removed | 10,445 cu.yd. |

HORSEPOWER SWEEPER:

Area swept to keep this district clean ..... 100,785,638 sq.yd.

Cost of horsepower sweeping

| Sweeping | | | Cost to clean once |
|---|---|---|---|
| Hired teams and teamsters | $9226.90 | | |
| Use city teams | 806.80 | $10,033.70 | $0.09955 per 1000 sq.yd. |
| Pilers | $9954.60 | 9,954.60 | $0.09885 per 1000 sq.yd. |
| Pick up | | | |
| Hired teams and teamsters | $5418.75 | | |
| Use city teams | 628.80 | | |
| Auto truck-drivers and helpers | 2276.03 | | |
| Auto truck rental (city) | 2231.70 | $10,555.38 | $0.1047 per 1000 sq.yd. |
| Sprinklers | | | |
| Hired teams and teamsters | $2090.00 | | |
| City teams | 3.75 | $2,093.75 | $0.020776 per 1000 sq.yd. |
| Maintenance sweepers | | | |
| Labor | $304.85 | | |
| Material | 825.42 | $1,130.27 | $0.011215 per 1000 sq.yd. |
| Totals horse sweeping | | $33,767.70 | $0.335091 per 1000 sq.yd. |
| Cost to clean 1000 sq.yd. once | | | 33¼c. |

GASOLINE POWER SWEEPER (one used as experiment):

Area swept to keep this district clean ..... 6,090,518 sq.yd.

Cost of auto-power sweeping

| Sweeping | | | Cost to clean once |
|---|---|---|---|
| Operator and helper | $420.00 | $420.00 | $0.06896 per 1000 sq.yd. |
| Pilers | $485.25 | $485.25 | $0.079672 per 1000 sq.yd. |
| Pick up | | | |
| Hired teams and teamsters | $18.00 | | |
| Use city teams | 10.50 | | |
| Auto truck-driver and helpers | 195.07 | | |
| Auto truck rental (city) | 164.75 | $388.32 | $0.06375 per 1000 sq.yd. |
| Maintenance sweeper | | | |
| Labor | $311.83 | | |
| Gasolene | 145.00 | | |
| Oil | 19.36 | | |
| Repairs | 247.85 | $724.04 | $0.10250 per 1000 sq.yd. |
| Totals auto sweeping | | $2,017.61 | $0.314882 per 1000 sq.yd. |
| Cost to clean 1000 sq.yd. once | | | 31.4c. |

HORSE AND AUTO-POWER SWEEPERS:

Since keeping 1,283,713 sq.yd. clean for 6¼ months and 477,584 sq.yd. clean for 5¼ months involved sweeping a total area of 106,876,156 sq.yd. this district must have been covered 110 times during the year at a cost of $36.89 per 1000 sq.yd. or ..... $35,785.31

CLEANING BY FLUSHERS:

| | |
|---|---|
| Total area of district kept clean | 806,129 sq.yd. |
| Total area flushed to keep this district clean | 70,381,682 sq.yd. |

Cost of cleaning by flushing:

| Flushing | | | Cost to clean once |
|---|---|---|---|
| Hired teams and teamsters | $8459.51 | | |
| Use city teams | 950.50 | $9,410.01 | $0.1336 per 1000 sq.yd. |
| Pilers | $9052.23 | $9,052.23 | $0.1286 per 1000 sq.yd. |
| Pick up | | | |
| Hired teams and teamsters | $1415.50 | | |
| Use city teams | 840.75 | $2,256.25 | $0.03206 per 1000 sq.yd. |
| Maintenance flushers | | | |
| Labor | $114.67 | | |
| Material | 127.34 | $242.01 | $0.00343 per 1000 sq.yd. |
| Totals flushing | | $20,960.50 | $0.297698 per 1000 sq.yd. |
| Cost to clean 1000 sq.yd. once | | | 29.7c. |

Cost to keep clean:

| | | | |
|---|---|---|---|
| Flushing | $9,410.01 | $0.01167 | per sq.yd. |
| Pilers | 9,052.23 | 0.01123 | per sq.yd. |
| Pick up | 2,256.25 | 0.002799 | per sq.yd. |
| Maintenance | 242.01 | 0.0003002 | per sq.yd. |
| Totals | $20,960.50 | $0.0259992 | per sq.yd. |
| Cost to keep 1000 sq.yd. clean | | | $26.00 |

Since keeping 806,129 sq.yd. clean involved flushing an area of 70,381,682 sq.yd. this district must have been covered 87.31 times during 5¼ months at a cost of $26.00 per 1000 sq.yd. or ..... $20,960.50

WHITE WINGS OR HAND CLEANING:

| | |
|---|---|
| Total area of district kept clean | 206,008 sq.yd. |
| Total area cleaned to keep this district clean | 63,886,054 sq.yd. |

| Cost of cleaning by hand | | | Cost to clean once |
|---|---|---|---|
| Patrol | $17,528.49 | $17,528.49 | $0.2744 per 1000 sq.yd. |
| Pick up | | | |
| Hired teams and teamsters | $1,486.50 | | |
| Use city teams | 596.50 | | |
| Auto truck-driver and helpers | 10.50 | | |
| Auto truck rental (city) | 24.50 | $2,118.00 | $0.03316 per 1000 sq.yd. |
| Maintenance tools | | | |
| Labor | $200.33 | | |
| Material | 178.85 | $379.18 | $0.005936 per 1000 sq.yd. |
| Totals hand cleaning | | $20,025.67 | $0.313496 per 1000 sq.yd. |
| Cost to clean 1000 sq.yd. once | | | 31.4c. |

Cost to keep this district clean:

| | | |
|---|---|---|
| Patrol | $17,528.49 | $0.08509 per sq.yd. |
| Pick up | 2,118.00 | 0.01028 per sq.yd. |
| Maintenance | 379.18 | 0.0018 per sq.yd. |
| Totals | $20,025.67 | $0.09721 per sq.yd. |

Since keeping 206,008 sq.yd. clean involved cleaning an area of 63,886,054 sq.yd. this district must have been covered 310 times during the year at a cost of $97.21 per 1000 sq.yd. or ..... $20,025.67

TOTAL STREET CLEANING AND AVERAGE UNIT COSTS FOR 1912:

| | | |
|---|---|---|
| Total area of paved streets cleaned | | 1,489,721 sq.yd. |
| Total area covered to keep clean | | 241,143,892 sq.yd |
| Cost to keep clean for one year | | |
| Cleaning | $68,037.33 | $0.04567 per sq.yd. |
| Auto rental | 2,420.95 | 0.001625 per sq.yd |
| Use city teams | 3,837.70 | 0.002577 per sq.yd. |
| Maintenance | 2,475.50 | 0.001662 per sq.yd. |
| Totals | $76,771.48 | $0.051534 per sq.yd. |
| Total average cost to keep clean | | $51.53 per 1000 sq.yd. |
| Total average cost to clean once | | 0.31 per 1000 sq.yd. |

Rate of wages paid:

| | |
|---|---|
| General foreman | $150.00 per month |
| Sub foreman | 95.00 per month |
| Hired teams with teamster | 6.00 per day |
| Teamsters | 3.00 per day |
| Use city teams | 1.50 per day |
| Laborers | 3.00 per day |
| Rental city auto truck | 7.00 per day |
| Truck driver and helpers | 3.00 per day |

*The record blank used is about 11 in. wide and 8 in. high. Space is provided for recording the yardage covered and the number of hours spent on each street by the subforeman, and by horse sweepers, power sweepers, flushers, pilers, pickup teams, sprinklers, auto-truck and laborers, followed by the per diem charge for each. In the upper left-hand corner there is a small tabular form with stubs for power, horse, flush and hand cleaning and column heads for dirt removed, (cu.yd.), water used (tanks of), and condition of weather. In the corresponding upper right-hand corner there is a space for date and remarks.

**The Right to Engage in Industrial Pursuits** has been granted to the State of Arizona and to municipalities in that state by a constitutional amendment recently adopted by a popular vote of 14,928 to 3602. At the same election an amendment was adopted extending the recall to all public officers, whether elected or appointed, and another one to the effect that taxes may be assessed as may be prescribed by law—evidently opening the way, constitutionally, for the single tax or any other method of taxation which the legislature may see fit to adopt.

# A New Entropy Analog*

By V. Karapetoff†

Thermodynamics is not the specialty of the writer of this article, but a few years ago he became incidentally interested in a certain phase of it, and made an effort to make clear to himself the physical concept of entropy. He finally worked out a mechanical analog, which may be of some interest to those who, like himself, are not satisfied with mathmetical definitions, but wish to have a physical picture, however imperfect. The analog is based upon the old idea of heat-fluid or caloric.[1]

In the two well known forms of energy, namely, mechanical energy and electrical energy, we usually distinguish the quantity factor and the intensity factor. Thus, the energy of the water in a storage reservoir is a product of the weight of the water, which is the quantity factor, by the hydraulic head, which is the intensity factor. The energy of a gas compressed in a tank is proportional to the quantity of gas, which is the quantity factor, and depends upon the pressure, which is the intensity factor. Again, in the case of electrical energy, the quantity of electricity, say in ampere-hours (or coulombs), is the quantity factor, and the voltage is the intensity factor.

Similarly, heat energy is characterized by an intensity factor, temperature, and a quantity factor called entropy. The concept of temperature is familiar to us all from our every-day experience, while that of entropy is entirely outside this experience and, therefore, presents considerable difficulty to a beginner. It is, therefore, desirable to explain entropy by means of analogs before taking up the study of mathematical thermodynamics.

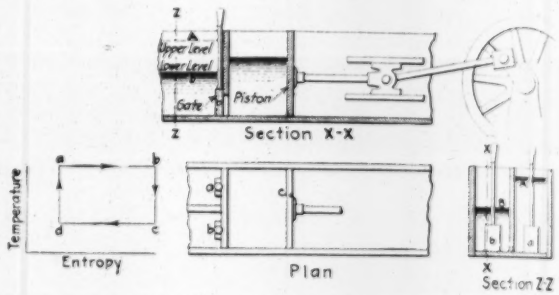
ZEUNER'S ANALOG—In a simple analog proposed by Zeuner,[2] temperature is compared to a difference of levels, and entropy to the weight of a body to be raised or lowered. The quantity of heat, being the product of the two, represents the amount of work necessary to raise the body by a certain height. For this reason entropy is sometimes called the "heat-weight." The familiar Carnot cycle, Fig. 1, is easily illustrated by this analogy. Think of a freight elevator which transfers, say barrels of flour from the upper to the lower floor of a warehouse. While barrels are being loaded on the elevator, its level, or temperature, remains constant, while the quantity of flour upon it, or its entropy, increases. This corresponds to the isothermal expansion along the part "a b" of the cycle. The energy of the elevator for positions above the lower floor of the warehouse increases with the distance, since the barrels represent a certain amount of stored energy.

Now, let the elevator be descending; its entropy, or the quantity of flour on it, remains constant, while the height above the lower floor (or what is called in thermodynamics, the "refrigerator") decreases. This corresponds to the adiabatic (or isoentropic) expansion "b c." Unloading the barrels on the lower floor corresponds to the isothermal rejection of heat during the part "c d" of the Carnot cycle. The flour may still possess a considerable amount of energy of position, say above the sea level, but this energy cannot be utilized, and must be considered as waste. Finally, the elevator returns into its original upper position, rising at a constant entropy, which in this case is the weight of the elevator proper; this corresponds to the adiabatic compression "d a." After this, the process is repeated in the same order.

This analog, in spite of its usefulness for the beginner, has a limited application only, and moreover, some of its inconsistences are apparent at once. For instance, no external work is performed during the period of loading the barrels, while a considerable amount of work is done by the gas during the isothermal expansion.

MACH'S ANALOGS—A better analog has been developed by Mach.[3] His idea is shown in Fig. 2 in application to a hydraulic motor, in which the head of the working fluid is analogous to temperature, and the quantity of the fluid behind the piston corresponds to entropy. A cycle analogous to that of Carnot may be realized on this model as follows: Let the pistol "C" be originally in its extreme left position, the gate "a" being open. The pressure on the piston corresponds then to the level of the water in the reservoir "A," which for our purpose must be assumed to be infinitely large, so that its level remains constant. The piston starts to the right, performing mechanical work, the gate "a" being open, and the water filling the space behind the piston. This corresponds to the isothermal expansion, during which the temperature is being kept constant, while the entropy increases. At a certain point of the travel, the gate "a" is closed, and the piston "C" allowed to move under the pressure of the water in the engine itself. As the volume of the space behind the piston increases, the level of the liquid becomes lower. This corresponds to the adiabatic expansion. The quantity of entropy (or water) remains constant, its temperature (water head) drops, and the work is performed at the expense of the potential energy of the water.

The piston is allowed to move until the level of the water sinks to that in the reservoir "B," which corresponds to the




Figs. 1 and 2. Temperature-Entropy Diagram and Hydraulic Analog of Carnot Cycle for Perfect Gas

refrigerator in thermodynamics. The gate "b" is now opened and the piston begins its return stroke, forcing the water into the reservoir "B." At a certain point of the stroke, the gate "b" is closed and for the rest of the movement the level of the water behind the piston rises to its original level, just as in the reservoir "A." The two last parts of the cycle are analogous, respectively, to the isothermal and adiabatic compressions in the Carnot cycle.

The result of the process is that a certain quantity of water has been transferred to a lower level, and the energy thus lost has been converted into mechanical work. Not all of the energy of the water taken from the higher reservoir can be converted into work, since the "exhaust" water in the motor must be at least at the level of the water in the reservoir "B." The efficiency of the arrangement depends upon the ratio of the heads in the two reservoirs above the sea level. Similarly, the efficiency of a Carnot cycle depends upon the ratio of the absolute temperatures of the source of heat and the refrigerator.

## THE PROPOSED ANALOG

STATEMENT—In the proposed analog, we endow matter with a certain structure, which permits us to form a clear picture of the phenomena in which temperature and entropy enter. No claim whatever is made that the suggested picture is more than an analog. It cannot be called an hypothesis of the structure of matter.

Consider gases and vapors to consist of very small particles (Fig. 3) separated by comparatively large spaces. The particles are assumed to be absolutely rigid and not in any motion, vibratory or translational, as is presupposed by modern theories of matter. To account for heat phenomena, we introduce again the old discarded caloric, or a hypothetical heat fluid. An atmosphere of this caloric is supposed to surround each particle of gas, as shown in Fig. 3, the particle itself being conceived as some sort of nucleus for the caloric. This conception of a gas is similar to that of Rankine's, except that he assumes the atmospheres to be elastic, and revolving or oscillating about their central points;[4] while for our purpose it is sufficient to suppose the substance of these atmospheres to be stationary.

Particles of caloric are supposed to repel each other, like the elements of an electric charge, and this repulsion is taken to be the cause of the elasticity of gases and vapors. The quantity of caloric in a given weight of gas represents its entropy, while the pressure in the caloric, due to the mutual repulsions of its particles is a measure of the temperature of the gas. In this wise, the quantity and the intensity factors of heat energy are represented by simple mechanical concepts.

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*From the "General Electric Review," January, 1913.

†Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

[1]After this article had been written, the author was gratified to read Prof. H. L. Callendar's address on "The Nature of Heat," in which this distinguished authority shows that "we might with advantage import into our modern theory some of the ideas of the old caloric or material theory which has for so long a time been forgotten and discredited." "Science," Vol. XXXVI, Sept. 13, 1912, page 321.

[2]Zeuner, "Technical Thermodynamics, Vol. I, Art. II.

[3]E. Mach, "Principien der Waermelehre," p. 329.

[4]W. J. M. Rankine, "Miscellaneous Scientific Papers," p. 17.

The particles of gas, or the nuclei, attract each other according to the ordinary law of gravitation, but the intermolecular distances being large, these attractions are supposed to be negligably small as compared to the repulsions caused by the caloric. Incidentally, these small attractions may be said to account for the deviation of gases from Boyle's law, and may be made to explain the behavior of saturated vapors, and the phenomena of liquefaction and solidification as will be shown below.

The process of communicating heat to a gas can be pictured by saying that the gas is connected to another body in which caloric is at a higher pressure than is the caloric in the gas. The caloric is thus forced to flow from the heat source into the gas and becomes associated with the atmospheres of its particles, increasing its entropy, which, according to the definition, is the quantity of caloric. Similarly, withdrawal of heat consists in connecting the gas to another body in which caloric is at a lower pressure, so that part of the heat matter or caloric constituting the atmosphere is dissociated and transferred to the colder body, where it becomes part of the atmospheres of its particles.

The intrinsic energy of a gas is the sum of the energies necessary to build up the atmospheres of its particles, bringing these particles together against their mutual repulsion. It will thus be seen that the heat energy, according to this picture, depends upon the temperature and entropy of the gas, in other words, upon the intensity and the quantity factors of thermal energy. This is similar to charging an insulated conductor with electricity; when bringing new infinitesimal charges to the conductor, it is necessary to overcome the repulsion of the charges already communicated to it, and the work done is stored as the potential energy of the charged conductor.

The above picture is not complete in one respect; namely, it does not account for irreversible thermodynamic processes, such as sudden expansion, friction, etc. Assuming that the whole universe were constituted as is described above, the entropy of the universe or the amount of caloric in it, would be constant, since caloric is considered as a sort of fluid, which is exchanged between bodies. But it is known that in reality the entropy of a system increases during an irreversible process, without any heat or entropy being communicated from outside. We shall assume, therefore, that in addition to the free caloric which constitutes the atmospheres of particles, the nuclei themselves contain vast stores of caloric in a bound state.

As long as heat exchange takes place infinitely slowly, all the particles of the gas participate in it equally, and the process is reversible, that is to say, may go either way. If, however, heat is communicated to only one part of the gas, or at a high rate disturbing the temperature balance, or if the equilibrium of some particles is disturbed mechanically, as during the process of friction, then some of the bound caloric is liberated out of the crevices of the nuclei. This assumption is made to account for the fact that entropy increases during an irreversible process. Entropy or caloric once liberated cannot be reduced back to the bound state, hence the total amount of entropy in the universe increases, this being a well known statement of thermodynamics.

It may be objected to the foregoing view that if a certain amount of gas be subjected to a great number of irreversible processes, it might finally lose all its bound caloric and thus change its physical or chemical properties. But, in the first place, the proposed structure of matter is intended merely to give a tangible picture of the actual phenomena—an analog which may go so far and no further In the second place, it is possible to assume that a molecule of gas contains an enormous quantity of bound caloric, so that it is impossible to say how many millions of changes it has to undergo before the change would become noticeable. A minute piece of radium emits its powerful radiation for years without changing in weight or in other properties to any measurable extent.

The principal difficulties in the way of a clear understanding of thermodynamic phenomena, from a physical point of view, are:

(1) The mysterious mechanism of conversion of heat into mechanical work, and vice versa;

(2) The temperature and the pressure of a gas are closely interdependent; but while one is a thermal property, the other is a mechanical property;

(3) Entropy, in spite of its great practical importance, remains but an abstract mathematical expression;

(4) The changes from a liquid or a solid state into a gaseous state, with the latent heats, critical point, change in volume, etc., are to be accepted as separate facts, without seeing the internal mechanism of these changes;

(5) It is not clear why the state of a substance may be defined by its thermal characteristics, entropy and temperature, as well as by its mechanical features, volume and pressure.

(6) In the study of irreversible phenomena, the fact of an increase in entropy without communication of heat from outside is obscure and seems contradictory in view of the original definition of entropy as $d\phi = dq/T$.

The analogy described above makes an understanding of these points much easier because one of the forms of energy, namely, heat, is eliminated from the beginning, and its factors, temperature and entropy, are replaced by simple mechanical properties of a hypothetical fluid. Therefore, an understanding of the six points enumerated above is facilitated in the following manner.

(1) The conversion of heat into work is replaced by a conversion of the potential energy of mechanical repulsions between particles into external work.

(2) Temperature, being compared to the pressure or potential of the caloric, naturally determines the forces of repulsion between particles, hence enters as a factor which determines the pressure of the gas.

(3) Entropy becomes simply the quantity of hypothetical caloric or heat-matter, a concept easy to understand. Communication of heat is pictured as adding a certain quantity of this matter at a certain pressure; that is, against definite repulsive forces.

(4) Changes of state are easily explained by considering the repulsive forces of the caloric and the forces of attraction between the nuclei.

(5) The physical state of a body is completely defined by its entropy and temperature (provided that a zero point of entropy is given), because these two determine the size of molecular atmospheres, and the distances at which these atmospheres must be placed in order that the caloric may have the required pressure. Hence, the volume of the gas and the forces of repulsion which determine its pressure become known.

(6) The study of irreversible phenomena is simplified by the assumption of liberation of bound caloric whenever unbalancing or mechanical shocks take place within the mass of the substance.

Some fundamental thermodynamic phenomena will now be described, using the language of the caloric theory, the structure of matter being assumed to be that shown in Fig. 3.

APPLICATION TO PERFECT GASES—A perfect gas, by

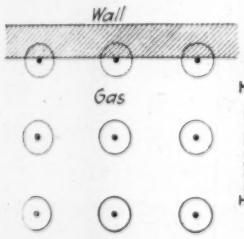


FIG. 3. GAS PARTICLES WITH CALORIC ATMOSPHERES

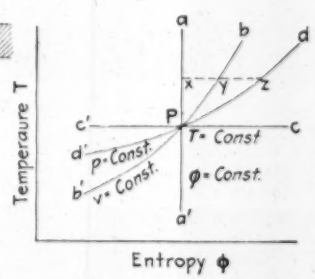


FIG. 4. CHANGES OF PERFECT GAS; TEMPERATURE AND ENTROPY TERMS

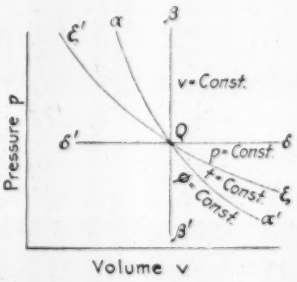


FIG. 5. CHANGES OF PERFECT GAS; VOLUME AND PRESSURE TERMS

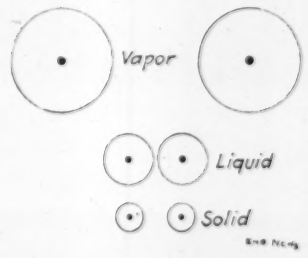


FIG. 6. INTERVALS AND CALORIC ATMOSPHERES IN VAPOR, LIQUID AND SOLID

definition, is one in which the distances between molecules are so large that the forces of attraction between them may be neglected altogether. The properties of such a gas are determined completely by the chemical structure of the molecule and by the quantity and pressure of the caloric associated with it. Let us consider four fundamental changes in such a gas, namely:

(1) At constant entropy (adiabatic);
(2) At constant volume;
(3) At constant temperature (isothermal);
(4) At constant pressure.

In all cases the changes will be presupposed to be so slow and uniform throughout the mass of gas that no bound caloric is liberated, hence the processes are reversible. In the following treatment, a kilogram of gas is supposed to be inclosed in a cylinder, the volume and the pressure being varied by means of a piston.

A change at constant entropy. Let "P" (Fig. 4) represent a definite state of a kilogram of gas in the temperature-entropy diagram, and let "Q" (Fig. 5) represent the same state in the pressure-volume diagram. A change at constant entropy is represented in Fig. 4 by the vertical line "aa'," the arrow indicating the direction in which the temperature increases. Referring to Fig. 3, it is easy to describe the physical character of the process, as shown by the corresponding curve $a a'$ in Fig. 5. Let the change be accompanied by an increase in volume, the distance between molecules increasing. By supposition, the entropy, or the quantity of caloric, remains constant, so that no heat is added to the gas; in other words, the molecular atmospheres in the new state possess the same amount of caloric as in the original state. The temperature is lower in the new position because we have defined temperature as the pressure to which caloric is subjected on account of the mutual repulsions of molecular atmospheres. This repulsion decreases as the distance between particles increases. Hence, the change is represented by the line "Pa'."

The pressure of the gas decreases for two reasons: First, the repulsions between particles decrease, as is explained above, and secondly, there are fewer particles per square meter of the piston in the new state than in the original state of the gas. Therefore, the pressure-volume curve has the shape $Qa'$, the pressure approaching zero as the volume increases indefinitely.

(2) A change at constant volume. Let a certain quantity of gas be heated at constant volume, or, according to our analogy, be connected to a body containing caloric at a higher pressure. Caloric will then flow into the gas and become associated with its atmospheres. Since the distances between the molecules remain the same, the repulsions within the caloric increase, so that both pressure and temperature increase. This change is represented by $Q\beta$ in Fig. 5, and by "Pb" in Fig. 4. If the gas is cooled, instead of being heated, the change is represented by the parts $Q\beta'$ and "Pb'" of the curves.

(3) A change at a constant temperature. This change may be accompanied either by an increase or by a decrease in volume. Let us consider an isothermal compression. The pressure in the caloric (but not in the gas) must, by assumption, remain the same as the distance between the molecules decreases. If the entropy were to remain constant, the pressure in the caloric would increase, because the repulsions between particles of the caloric are stronger at shorter distances. Hence, in order to keep the same temperature of the gas, part of the caloric must be removed as the intermolecular distances decrease. In other words, an isothermal compression is accompanied by withdrawal of heat, and the entropy of the gas decreases. This is shown by curve "Pc'" in Fig. 4.

The corresponding curve $Q\zeta'$ shows the increase in pressure during this process; this curve is not as steep as the curve $Qa'$ of the adiabatic compression, because during the latter process no entropy or caloric is abstracted from the gas, so that both the pressure and the temperature increase more rapidly. An isothermal expansion is represented by the parts "Pc" and Q of the curves. Here entropy must be added to the gas, as otherwise the pressure in the caloric would decrease with the increase in distance between the molecules.

(4) A change at constant pressure. Let the process be an expansion represented by $Q\delta$ in Fig. 5. Since with the increase in volume fewer particles of gas press upon one square unit of the area of the piston, the force of repulsion exerted by each particle must be increased in order that the sum of the forces per unit area of the piston remain constant. Without the addition of caloric, both the temperature and the pressure decrease during the expansion, as shown by the curves "Pa'" and $Qa'$; hence in the process under consideration, entropy must be added during the expansion. Next it can be shown that more entropy must be added than for the same change in volume when the expansion is isothermal. This follows directly from the shape of the curve $Q\zeta'$, because there the caloric added is not sufficient to keep the pressure constant. Therefore, when enough caloric is added to keep the pressure constant, the temperature of the gas increases, and hence the curve has the shape "Pd," showing that the temperature increases with the entropy.

It remains to show that "Pd" lies below the curve "Pb" corresponding to a constant volume. This is equivalent to saying that for a given increase in temperature, such as "Px" in Fig. 4, more caloric must be added along "Pd" than along "Pb." This becomes self-evident when it is remembered that in the state represented by the point "z," the particles are further apart than in that represented by point "y," so that more caloric is necessary to produce the same pressure in it. Hence, "xz" is larger than "xy," and the curve "Pd" lies below "Pb."

Another way of demonstrating this is by saying that with the expansion at constant pressure the energy added to the gas is partly expended in external work, so that with the same limits of temperature more entropy must be added when the volume increases. A direct result of this statement is that the specific heat at constant pressure is larger than the specific heat at constant volume.[5]

The diagram in Fig. 4 is divided by the line "aa'" into two parts. For all points to the left of this line the entropy, or the quantity of caloric, is less than in the state represented by the point "P" for all points to the right the entropy is larger than in the initial state represented by "P." Similarly, the line "cc'" divides the plane into two parts corresponding to temperatures respectively higher and lower than at "P." The curve "bb" separates points of expansion from those of contraction and the curve "dd'" points of pressure higher than that in the initial state "P" from those lower than at "P." Hence, it is possible to define qualitatively the state of a gas represented by a point, according to its place in one of the eight sectors of the diagram.

The pressure-volume diagram (Fig. 5) is similarly divided into eight sectors. In this wise, an arbitrary thermal change of state may be represented by a succession of two or more standard changes. One must keep in mind, however, that the heat added or subtracted and the external work performed depend upon the path, while changes in entropy and in intrinsic energy are independent of the path between two points, each representing a state of gas.

VAPORS, LIQUIDS AND SOLIDS—When the temperature of a gas is reduced and the pressure is increased, particles are brought closer and closer together, so that finally the forces of attraction between nuclei become of the same order of magnitude as the repulsions between the caloric atmospheres. Under these circumstances, changes of state are determined by the balance of repulsive and attractive forces, and in general three kinds of aggregation are possible (Fig. 7).

The first state, that of a vapor, is similar in general to the state of a perfect gas considered in the previous section, except that the disturbing action of attractive forces modifies the simple laws of change of state. By removing some caloric, the particles may be brought much closer together. Without the central nuclei, this would involve enormous repulsive forces, but the attraction between the nuclei compensates for a considerable portion of the repulsion, so that a new state with new properties becomes possible at moderate pressures—that of a liquid.

By removing still more caloric, it is possible to make the molecular attractions larger than the repulsions, so that the particles are held together at a definite distance without external pressure. This is the solid state. To change from the gaseous to the liquid state, considerable amounts of entropy or caloric must be removed. The energy thus abstracted per kilogram of the substance is called the latent heat of evaporation, when the temperature, or the caloric pressure, is the same in both states. Similarly, the energy abstracted per unit weight during the process of solidification is called the latent heat of fusion.

If the original temperature of a vapor is sufficiently high, the forces of repulsion between the caloric atmospheres increase so rapidly when the molecules are brought closer together, that it is impossible to find another position of equilibrium at the same pressure and temperature. This means that at this temperature the vapor cannot be condensed or liquefied. The highest temperature at which liquefaction is possible is called the critical temperature; to this temperature corresponds a definite pressure and volume, also called critical.

IRREVERSIBLE CHANGES—It is mentioned above that in order to explain irreversible phenomena it is necessary to assume some of the caloric to be in a bound state within each

[5]Specific heat is represented graphically by the length of the subtangent to the temperature-entropy curve. We have by definition $dQ = cdT = Td\phi$, so that $c = T(d\phi/dT)$, which is the length of the subtangent to the curve $T = f(\phi)$.

molecule. This bound caloric is supposed to be liberated during irreversible phenomena, in order to account for an increase in entropy during such phenomena. We shall now consider some irreversible phenomena in the light of this picture.

(1) Joule's Experiment. Joule's classical experiment consisted in expanding a gas without performing external work. A vessel was filled with a gas, and connected by a pipe provided with a stop-cock to another vessel maintained at a high vacuum. The whole system was immersed in a liquid bath. When a thermal equilibrium was established everywhere, the stop-cock was opened and the pressures in the two vessels were allowed to equalize. After the equilibrium had been again established, it was found that the temperature of the system was not changed. This showed that no energy was required to separate particles of gas, and no heat was added to the gas, since no external work was performed. At the same time it can be shown mathematically that the entropy in the expanded state is considerably higher than that in the initial state. Inother words, the entropy of the system is in this case increased without adding any heat from outside. This can be explained in the light of our analogy as follows: The experiment shows the temperature in the expanded state to be the same as in the original state; this means that the pressure in the caloric remains the same. But in the final condition the particles are further apart; hence, in order to produce the same "caloric pressure" there must be more caloric in each molecular atmosphere. But since no heat has been added from outside, this caloric must be liberated out of the molecules themselves.

The liberation of the bound caloric may be explained as due to an unbalancing of pressure in the mass of the gas, and to mechanical shocks between the molecules during the process of equalizing of pressures. The efflux of the gas being sudden, it is accompanied by eddies; moreover, new molecules streaming out of the first vessel collide with those in the second vessel; and the energy of these shocks, not being utilized for external work, goes to liberate the bound caloric. Since the intrinsic energy of a perfect gas is a function of its temperature only, or of the pressure of its caloric, enough caloric is liberated to bring the pressure to its former value. This is required by the law of conservation of energy: No external work was performed, and the gas possesses no kinetic energy at the end of the experiment; therefore, its potential energy must be the same as in the beginning.

The process is irreversible, because by assumption the caloric once liberated cannot be reduced again to the bound state. Should the gas be compressed to its original volume, the new caloric previously added to the old would raise the temperature of the gas. Or, if the compression be done at a constant temperature, some of the caloric has to be removed. In either case the conditions at the end are different from those at the beginning; mechanical work must be performed and an equivalent amount of heat stored in the gas or conducted away. A reversible process is by definition one which being repeated in the opposite direction cancels separately the work performed and the heat liberated or spent. In the light of our analog, only such processes are reversible in which no bound caloric is liberated. Once some caloric is liberated the process becomes irreversible.

Clausius' famous maxim, "The entropy of the world tends toward a maximum," receives thus a simple meaning. Most processes in nature are more or less violent, unbalanced, and hence, using our picture, are accompanied by the liberation of some bound caloric. Thus the entropy of the world (the total quantity of liberated caloric) increases indefinitely, while the total energy remains constant.

(2) Liberation of heat by friction. Let two bodies, assumed to be poor conductors of heat, be rubbed one upon another: The process is necessarily accompanied by shocks communicated to the particles in contact and the energy of these shocks causes some caloric to be liberated. In this way, the pressure of the free caloric, or what is the same, the temperature of the bodies is raised. The process is irreversible: a mere cooling of the surface would conduct away the extra caloric without producing any mechanical motion.

(3) Conduction of heat. Let two reservoirs of heat, A and B, be connected by a heat conductor C. Let the body A be at a higher temperature than that of the body B. The conductor C, through which heat is flowing, possesses temperatures varying between those of A and B.

The transfer of heat may be pictured as a flow of caloric from one molecule to the next, the cause being the difference of pressures in the atmospheres of these molecules. The molecule nearest the body B, being a little warmer than the body B itself, gives up part of its caloric, with the result that some caloric flows into it from the next warmer molecule, tending to equalize the caloric pressures. It is easy to see, however, that such a mechanism would contradict the law of conservation of energy, because the final result would be a transfer of some caloric from a higher to a lower pressure, without the performance of an equivalent amount of external work. But since there is no possibility of performing external work in the phenomenon itself, the energy of the caloric serves to liberate bound caloric of the molecules of the conductor C.

The phenomenon may be compared to that of a snow ball rolling slowly down a snow-covered hillside, and increasing in size by the addition of snow on its path. The speed of the ball does not increase, but its energy is used to accelerate new snow which adheres to it. So in the case of conduction of heat, each transfer of caloric from one molecule to the next is accompanied by the liberation of some bound caloric from the nucleus of the latter molecule. In the end, the lower reservoir receives more entropy than is lost by the upper reservoir, this being necessary to satisfy the law of conservation of energy.

The phenomenon is irreversible, first, because the caloric once liberated cannot be reduced again to the bound state, and second, because it is impossible to make the caloric flow from a lower to a higher pressure.

## A Duplex Rock Channeler with Turntable*

Some interesting features in rock-cutting machinery are presented by a channeling machine in one of the quarries of the Indiana oölitic limestone field. It is of the duplex type, having two chopping engines and two gangs of steel cutters arranged side by side, and it carries a vertical boiler supplying steam at 140 lb. pressure. The machine travels on a track of 6 ft. 9 ¼ in. gage (which permits of cutting blocks to standard mill size), and by means of a special turntable it can be swung round so that two parallel cuts 8 ft. apart (on opposite sides of the track) can be made at one setting of the track. Duplex channeling machines have been used previously in marble quarries, and were described in our issue of Nov. 18, 1909, but they are said to be of special advantage in cutting soft limestone. The new machine, however, has 8-in. cylinders as compared with 6½-in. cylinders in the marble-cutting machine. The pistons work alternately, one making the downward cutting or chopping stroke while the other is on the upward or return stroke, thus reducing jar and vibration. It is stated also that in channeling "blind" cuts (without an open end for the escape of sludge) the duplex machine has an advantage over the single-head machine in keeping the mud thinner by stirring it up, while the front gang pushes the mud ahead and enables the rear gang to give a free blow upon the rock. The crew consists of three men, the same as in the single-gang channeler.

The feed screw is placed between the cylinders, and where there is ample room overhead, the screw extends upward through the top of the standard in which is located the feed nut, driven by the usual bevel gears and chain. Where the overhead room is limited, as in tunnel work, the feed screw extends downward. This screw runs in an oil bath, which cools it and insures lubrication, oil being forced up the hollow screw and nut and through small holes to the threads within the nut. The feed screw permits a 36-in. run, so that it is necessary to change steels only every 3 ft. of cut. The starters, however, cut only 12 to 14 in. deep in order to secure stiffness in the gangs. Either one of the chopping engines can be operated independently.

The turntable, which enables the machine to cut on

*From information furnished by the Sullivan Machinery Co., Chicago.

both sides of its track, consists of a section of track 10 ft. long, carrying between the rails a Z-bar ring which forms the lower or fixed race for a large roller thrust bearing. The rolls consist of hardened steel discs about 4 in. diameter, and to maintain their spacing, hoops are provided which carry small rolls on vertical axes to take the horizontal thrust. Another Z-bar ring inside of and over the rolls forms the upper or moving race. To turn the channeler, it is run onto the turntable section and lifted by jacks (on the machine) until the wheel flanges clear the rails. It is then swung around, and lowered to the rails in the reversed position. The operation may be accomplished in 14 to 18 min. by three men. In a simplified design, eliminating the jacks, the turntable will consist of a plain ring, bolted and braced to the rails. Above this will be a similar ring bolted to a shorter and lighter track section, of the same gage. A roller bearing will be placed between the rings and a center pin will carry side and end thrust. Two short pieces of rail, beveled to provide an incline, will furnish access to the turntable.

Observations were made of the operation of the machine under practical quarrying conditions and in comparison with three 7-in. single channelers. A summary of the results is shown in the accompanying table. The duplex machine was at a disadvantage in that only its own crew of three men was available for moving track, while the three single machines (on one track) had nine men (three crews) for this purpose. In spite of delays and handicaps, the average cut per day of the duplex machine was nearly 2½ times that made by one single machine. Its actual cutting speed, indicated by the average cut per hour of running time, was more than three times that of one single machine. The track speed of the duplex channeler in this stone was 34 ft. per minute.

COMPARATIVE PERFORMANCE OF DUPLEX AND SINGLE-HEAD ROCK CHANNELERS

| | 1 Duplex | 1 Single | 3 Singles |
|---|---|---|---|
| Ave. cut per day | 670.0 sq.ft. | 283.0 sq.ft. | 848.0 sq.ft. |
| Ave. cut per hour | 72.2 sq.ft. | 30.5 sq.ft. | 91.5 sq.ft. |
| Ave. cut per hour, running time | 140.0 sq.ft. | 46.0 sq.ft. | 138.0 sq.ft. |
| Ave. day's time | 9.27 hr. | 9.27 hr. | 9.27 hr. |
| Ave. running time per day | 4.78 hr. | 6.15 hr. | 6.15 hr. |
| Ave. exceptional delays per day | 1.04 hr. | none | none |

# Train Resistance Tests, Southern Pacific Ry.

*SYNOPSIS—The effect of curves in increasing train resistance is an important factor in the operation of railways or railway divisions having heavy grades and curves in combination, and it is established practice to reduce the rate of grade on curves so that the combined resistance due to grade and curve will not exceed the resistance due to the maximum grade on tangents. Although this compensation of grade for curvature is a matter of great importance in the handling of traffic and has been investigated quite extensively, the investigations have been mainly theoretical, while experimental work and the observation of conditions in actual service have been comparatively limited. For this reason we are specially pleased to put before our readers a description of a series of careful observations made with regular freight trains, and, although these were made thirty years ago, their results represent a very important addition to the available information upon the subject.*

The subject of compensating grades for curvature was discussed at some length in our issue of Aug. 15, 1912, and reference was made to the very small amount of actual test and observation upon the subject. As a result of the articles then published, we have received particulars of experiments made in 1883 with freight trains in regular service on the Southern Pacific Ry. In furnishing us with the tabulated results of the observations, Wm. Hood, Chief Engineer of that company, states that they have never been published before.

The experiments were made by observing the speed of the train on the successive curves and tangents on a certain stretch of road, the alignment and profile of which were known. The tabulations for the several observations show the results for 13 trains on ten stretches of line, and in the accompanying table we have condensed the records for seven of these trains on five stretches of line. On some of these stretches (*A*, *B* and *C* of table) the compensation was on a sliding scale ranging from 0.02 to 0.04% per degree of curvature, while on others (including *D* and *E* of the table) it ranged from 0.02 to 0.05% per degree, as shown in the table below:

| Comp. = 0.02 to 0.04% per deg. | | Comp. = 0.02 to 0.05 per deg. | |
|---|---|---|---|
| 1° and over | 0.020 | 1° and over | 0.020 |
| 4° and over | 0.025 | 3° and over | 0.025 |
| 6° and over | 0.030 | 4½° and over | 0.030 |
| 8½° and over | 0.035 | 6° and over | 0.035 |
| 10° and over | 0.040 | 8° and over | 0.040 |
| | | 9° and over | 0.045 |
| | | 10° and over | 0.050 |

The experiments were made on long continuous maximum grades having the rate of grade reduced on curves to the extent indicated above and shown in the table. The trains were those in regular freight service, and were not made up specially for the purpose. The nearly uniform steam pressure and fixed opening of throttle and cut-off gave nearly uniform tractive power for considerable periods. The speed is given in miles per hour and also in the number of revolutions per 15 sec., the latter observations showing at once any variation in the speed and also serving to show when slipping occurred. These two columns of speed indicate (for such locomotives and train lengths as were used) a practically correct reduction of grades on the curves, for all the lines under observation, showing a marked uniformity of speed on curves and tangents. In certain isolated cases (marked by a star in the table) there is shown an acceleration on the curves, indicating that the compensation is a little in excess of requirements. In a few other isolated cases the observations show a successive reduction of speed on the curves, indicating that the compensation is slightly deficient. Enginemen operating trains over the same stretch of line and the same maximum grade differ in opinion as to where the hardest pull occurs, although each one has in mind some point or points where the train seems to him to pull the hardest.

The length and other features of the trains used in the observations are given below. When the curve or tangent was shorter than the length of the train, the speed was noted when the middle of the train was at the middle of the short curve or tangent. When the length was equal to or greater than that of the train, the speed was noted near the up-grade end of the curve or tangent, in order that the full effect of the alignment might appear in the

TABLE SHOWING RELATION OF GRADE COMPENSATION FOR CURVES TO SPEED OF TRAINS: SOUTHERN PACIFIC RY.

Compensation 0.02 to 0.04% per degree

| Alignment Deg. Min. | Length of curve or tangent ft. | Grade per cent. | Grade red. per sta. per degree | Speed Train No. 1 M.p.h. | Revs. in 15 sec. | Train No. 2 M.p.h. | Revs. in 15 sec. |
|---|---|---|---|---|---|---|---|
| **A. Trains over Soledad Pass (Southbound)** | | | | | | | |
| Maximum tangent grade, 2.2% | | | | | | | |
| 0 20 L | 2782 | 2.20 | none | 13.5 | 21 | 9.0 | 14 |
| 6 00 L | 440 | 2.02 | 0.03 | 10.9 | 17 | 9.0 | 14 |
| 1 00 L | 1117 | 2.183 | 0.02 | 9.6 | 15 | 9.0 | 14 |
| Tan | 181 | 2.183 | ... | ... | ... | 9.0 | 14 |
| 3 00 R | 717 | 2.14 | 0.02 | 9.0 | 14 | 9.0 | 14 |
| 7 00 R | 1436 | 1.99 | 0.03 | 9.0 | 14 | 8.4 | 13 |
| 0 30 R | 990 | 2.20 | none | 7.7 | 12 | 8.4 | 13 |
| 3 00 R | 400 | 2.161 | 0.02 | 7.7 | 12 | 8.4 | 13 |
| Tan | 217 | 2.161 | ... | 7.7 | 12 | 8.4 | 13 |
| 7 00 L | 458 | 1.99 | 0.03 | 8.4 | 13 | 8.4 | 13 |
| Tan | 150 | 2.148 | ... | 8.4 | 13 | ... | ... |
| 3 00 R | 1165 | 2.148 | 0.02 | 8.4 | 13 | 8.4† | 13 |
| Tan | 2260 | 2.20 | ... | 8.4 | 13 | 9.0† | 14 |
| 6 00 L | 710 | 2.02 | 0.03 | 7.7 | 12 | 8.4† | 13 |
| Tan | 1085 | 2.20 | ... | 7.7 | 12 | 9.0† | 14 |
| 4 30 R | 680 | 2.11 | 0.02 | 7.7 | 12 | 8.4† | 13 |
| Tan | 179 | 2.161 | ... | 7.7 | 12 | 8.4 | 13 |
| 2 30 L | 752 | 2.161 | 0.02 | 8.4* | 13 | 8.4 | 13 |
| **B. Trains over Soledad Pass (Northbound)** | | | | | | | |
| Maximum tangent grade, 2.2% | | | | | | | |
| | | | | Train No. 3 | | Train No. 4 | |
| 3 00 L | 874 | 2.14 | 0.020 | 14.1 | 22 | 10.9 | 17 |
| Tan | 1059 | 2.20 | ... | 11.6 | 18 | 10.9 | 17 |
| 1 20 R | 1448 | 2.176 | 0.020 | 10.9 | 17 | 10.9 | 17 |
| 1 20 R | 1448 | 2.176 | 0.020 | 10.3 | 16 | ... | ... |
| Tan | 200 | 2.176 | ... | 9.6 | 15 | ... | ... |
| 8 00 L | 683 | 1.96 | 0.030 | 9.6 | 15 | 9.6 | 15 |
| Tan | 1393 | 2.20 | ... | 9.6 | 15 | 9.6 | 15 |
| 3 00 R | 1017 | 2.14 | 0.020 | 9.0 | 14 | 9.6 | 15 |
| Tan | 2294 | 2.20 | ... | 9.0 | 14 | 9.6 | 15 |
| 4 00 L | 400 | 2.144 | 0.020 | 9.0 | 14 | 9.6 | 15 |
| Tan | 171 | 2.144 | ... | ... | ... | ... | ... |
| 6 00 R | 450 | 2.02 | 0.030 | 8.4 | 13 | Slipped | |
| 2 30 R | 535 | 2.15 | 0.020 | 8.4 | 13 | 8.4 | 13 |
| Tan | 382 | 2.197 | ... | 8.4 | 13 | ... | ... |
| 1 00 L | 799 | 2.197 | 0.020 | 9.0 | 14* | 8.4 | 13 |
| Tan | 237 | 2.197 | ... | 8.4 | 13 | ... | ... |
| 4 00 R | 687 | 2.134 | 0.020 | 8.4 | 13 | Slipped | |
| Tan | 150 | 2.134 | ... | 8.4 | 13 | 8.4 | 13 |
| 8 00 L | 309 | 1.96 | 0.030 | 8.4 | 13 | 8.4 | 13 |
| 0 20 L | 994 | 2.20 | none | 8.4 | 13 | 8.4 | 13 |
| 8 00 L | 453 | 1.99 | 0.030 | 8.4 | 13 | 8.4 | 13 |
| Tan | 161 | 1.99 | ... | ... | ... | ... | ... |
| 8 00 R | 655 | 1.99 | 0.030 | 8.4 | 13 | 8.4 | 13 |
| Tan | 363 | 2.176 | ... | 8.4 | 13 | 8.4 | 13 |
| 1 40 L | 1710 | 2.176 | 0.020 | 8.4 | 13 | 8.4 | 13 |
| 1 40 L | 1710 | 2.176 | 0.020 | 9.0 | 14* | ... | ... |
| Tan | 272 | 2.176 | ... | ... | ... | ... | ... |
| **C. Train over San Pedro Pass (Westbound)** | | | | | | | |
| Maximum tangent grade, 1.4% | | | | | | | |
| | | | | Train No. 5 | | | |
| 1 00 L | 1018 | 1.305 | ... | 15.4 | 24 | | |
| Tan | 1939 | 1.400 | ... | 13.5 | 21 | | |
| 2 00 L | 1000 | 1.360 | 0.020 | 12.9 | 20 | | |
| Tan | 672 | 1.400 | ... | 12.2 | 19 | | |
| 5 00 R | 588 | 1.287 | 0.025 | 11.6 | 18 | | |
| Tan | 186 | 1.287 | ... | 10.9 | 17 | | |
| 5 00 L | 1235 | 1.287 | 0.025 | 10.9 | 17 | | |
| Tan | 299 | 1.400 | ... | 10.9 | 17 | | |
| 10 00 R | 490 | 1.050 | 0.040 | 10.9 | 17 | | |
| Tan | 150 | 1.050 | ... | 10.9 | 17 | | |
| 10 00 L | 560 | 1.050 | 0.040 | 10.9 | 17 | | |
| Tan | 476 | 1.40 | ... | 10.3 | 16 | | |
| 6 00 L | 253 | 1.22 | 0.030 | 10.9 | 17 | | |
| Tan | 205 | 1.40 | ... | 10.9 | 17 | | |
| 9 00 R | 876 | 1.085 | 0.035 | 10.9 | 17 | | |
| 2 30 R | 665 | 1.35 | 0.020 | 10.9 | 17 | | |
| Tan | 356 | 1.40 | ... | 10.9 | 17 | | |
| 10 00 L | 586 | 1.051 | 0.040 | 10.9 | 17 | | |
| Tan | 159 | 1.051 | ... | 10.9 | 17 | | |
| 10 00 R | 506 | 1.051 | 0.040 | 10.9 | 17 | | |

Compensation 0.02 to 0.05% per degree

| Alignment | Length of curve or tangent, ft. | Grade per cent. | Grade red. per sta. per degree | Speed of train M.p.h. | Revs. in 15 sec. |
|---|---|---|---|---|---|
| **D. Train over Maricopa Pass (Eastbound)** | | | | | |
| Maximum tangent grade, 1% | | | | | |
| | | | | Train No. 6 | |
| 7 30 L | 1308 | 0.737 | 0.035 | 13.6 | 19 |
| Tan | 450 | 1.00 | ... | 12.9 | 18 |
| 6 00 R | 2404 | 0.79 | 0.035 | 11.4 | 16 |
| Tan | 4072 | 1.00 | ... | 11.4 | 16 |
| 5 45 L | 1264 | 0.827 | 0.030 | 11.4 | 16 |
| Tan | 1022 | 1.00 | ... | 11.4 | 16 |
| 7 45 L | 1258 | 0.729 | 0.035 | 11.4 | 16 |
| Tan | 200 | 1.00 | ... | ... | ... |
| 2 00 L | 982 | 0.96 | 0.020 | 11.4 | 16 |
| Tan | 268 | 1.00 | ... | ... | ... |
| 2 00 R | 637 | 0.96 | 0.020 | 11.4 | 16 |
| Tan | 1589 | 1.00 | ... | 11.8 | 16½ |
| 1 30 L | 2602 | 0.97 | 0.020 | 12.1* | 17 |
| Tan | 652 | 1.00 | ... | ... | ... |
| 3 00 R | 1371 | 0.925 | 0.025 | 12.1 | 17 |
| Tan | 1596 | 1.00 | ... | 12.1 | 17 |
| 3 00 R | 552 | 0.925 | 0.025 | 12.5* | 17½ |
| Tan | 1452 | 1.00 | ... | 12.5 | 17½ |
| 1 30 L | 967 | 0.97 | 0.020 | 12.5 | 17½ |
| **E. Train over Sierra Blanca (Eastbound)** | | | | | |
| Maximum tangent grade, 1% | | | | | |
| | | | | Train No. 7 | |
| 6 00 L | 746 | 0.79 | 0.035 | ... | ... |
| Tan | 924 | 1.00 | ... | 10.9 | 17 |
| 2 30 R | 780 | 0.937 | 0.020 | 9.6 | 15 |
| Tan | 711 | 1.00 | ... | 9.6 | 15 |
| 5 00 R | 1193 | 0.85 | 0.030 | 9.6 | 15 |
| Tan | 2169 | 1.00 | ... | 9.6 | 15 |
| 4 05 L | 2226 | 0.877 | 0.030 | 9.6 | 15 |
| Tan | 1456 | 1.00 | ... | 9.6 | 15 |
| 3 30 L | 363 | 0.912 | 0.025 | 9.6 | 15 |
| Tan | 562 | 1.00 | ... | 9.6 | 15 |
| 4 30 R | 1390 | 0.865 | 0.030 | 9.6 | 15 |
| Tan | 485 | 1.00 | ... | 9.6 | 15 |
| 2 00 L | 653 | 0.96 | 0.020 | 9.6 | 15 |
| Tan | 1314 | 1.00 | ... | 9.6 | 15 |
| 3 00 R | 861 | 0.925 | 0.025 | 9.6 | 15 |
| Tan | 475 | 1.00 | ... | 9.6 | 15 |
| 9 30 L | 954 | 0.572 | 0.045 | Slipped | |
| Tan | 843 | 1.00 | ... | 9.0 | 14 |
| 5 30 R | 767 | 0.835 | 0.030 | 9.6 | 15 |
| Tan | 831 | 1.00 | ... | 9.0 | 14 |
| 7 30 R | 841 | 0.737 | 0.035 | 9.6 | 15 |
| Tan | 540 | 1.00 | ... | 9.0 | 14 |
| 9 30 R | 1139 | 0.572 | 0.045 | 9.6 | 15 |
| Tan | 336 | 1.00 | ... | 9.6 | 15 |
| 7 30 L | 383 | 0.737 | 0.035 | 9.6 | 15 |
| Tan | 453 | 1.00 | ... | 9.0 | 14 |
| 4 00 L | 431 | 0.88 | 0.030 | 9.0 | 14 |
| Tan | 897 | 1.00 | ... | 8.7 | 13½ |
| 10 00 L | ... | 0.477 | 0.050 | ... | ... |

Note.—At points marked * the speed on the curve is slightly higher than on the preceding tangent, indicating that the compensation was slightly in excess of the requirement. This reduces the resistance and enables the train to accelerate on the curve.

recorded speed of the train. Higher rates of speed near the bottom of the grades are due to the practice of "making a run" for the grade. In cases where short tangents have the same rate of grade as the adjacent curve or curves the reduction of grade due to the curvature is distributed over the curve (or curves) and short tangent.

The trains were made up mainly of box cars of 30,000 and 40,000 lb. capacity. The average load of general merchandise per loaded freight car in these tests was 20,635 lb. The average light weight of box cars of 30,000 and 40,000 lb. capacity was 19,750 and 21,670 lb., respectively, and a caboose was rated as equivalent to an average loaded box car. The several trains follow:

Train No. 1. Two engines, with cylinders 18x24 in., and having a weight of 32 tons, on six driving wheels 4 ft. 7 in. in diameter. One caboose, three emigrant sleeping cars and 19 box cars (two empty). Approximate weight of train (exclusive of engine), 390 tons; approximate length, 750 ft. One engine had full throttle opening and 122 to 125 lb. steam pressure; the other had 80% throttle and 120 lb. pressure.

Train No. 2. Two similar engines, caboose, one emigrant sleeping car and 19 box cars. Approximate weight of train, 240 tons; approximate length, 750 ft. Throttle and boiler pressure as above.

Train No. 3. Two similar engines, one caboose, nine emigrant sleeping cars, 19 box cars. Approximate length, 750 ft.

Train No. 4. Two similar engines, one caboose, one sleeping car and 19 box cars. The train length and conditions of boiler pressure and throttle opening were approximately the same on all these four trains.

Train No. 5. Two similar engines, one caboose and 25 freight cars. Approximate length, 906 ft. One engine with full throttle and 112 lb. to 117 lb. pressure; the other with 50% throttle and 125-lb. pressure.

Train No. 6. One engine with cylinders 17x24 in. and having a weight of 21½ tons on four driving wheels 5 ft. in diameter. One caboose and 19 box cars. Approximate length, 663 ft. Throttle opening, 80%. Boiler pressure, 125 lb., increasing to 128 lb. during the latter part of run.

Train No. 7. One engine of the larger size noted above, 14 box cars, two flat cars, two water-tank cars, one emigrant car and caboose. Approximate length, 670 ft. Throttle half open. Boiler pressure, 120 lb.

# The Study of Modern Languages in Technical Schools

By Winslow H. Herschel*

For the first hundred years after the founding of Harvard College, over a third of its graduates entered the ministry. It was held at that time that the chief aim of education was to give a broad, general culture. With the realization that college prepares, or should prepare, for any vocation, and the consequent increase in the number seeking a college education, there has come a tendency to make education of more direct utility, to hold as an ideal the accumulation of information rather than the acquiring of a gentlemanly polish.

But the mere storing up of facts in the memory is of value chiefly to the student who is obliged to seek, on graduation, the highest salary possible, regardless of opportunities for advancement. An engineering student may obtain a position as draftsman or transitman, or he may acquire enough manual dexterity in shopwork to take a position as machinist; but it is not till he has been out of college some time, and has worked his way up to a position in which he must make new applications of old principles, that his training begins to tell, and he shows himself superior to the man who has worked his way up from blueprint boy or rodman, without having gained, in one way or another, a broad education.

Any school must, to some extent, compromise in its curriculum between those studies which will be of greatest immediate use to the student on graduation, and those which will best prepare him to take advantage of opportunities for advancement. Herein lies the essential difference between a trade school and a technical school. The former prepares for the immediate future; the latter pays more attention to the high positions to which it is assumed the graduates will ultimately attain.

There are several reasons why the accumulation of facts is not the most important thing. In the first place, the college period, even if extended to five or six years, is not long enough to accumulate, to say nothing of assimilate, all the facts that one will need in a lifetime. In the second place, engineering is a growing science, electrical engineering, in fact, grows so fast that it almost takes one's breath away. An engineer is not very long out of college before he realizes that he must be learning continuously to keep abreast of the times, even if blest with so good a memory as to make it unnecessary to relearn a subject once understood. And such memories are rare. Thirdly, an engineer may, in the course of his active life, change his vocation, in whole or in part, from one branch of engineering to another.

It is clear, therefore, that facts learned in college are of little importance in comparison with the ability to acquire new information, and it is from this standpoint that we must judge an engineering curriculum.

There are three general reasons for the study of modern languages which we may call cultural, commercial and professional. There can be little question concerning the cultural value of the study of languages. The objection is apt to be that the engineer does not need, or cannot afford the time for mere cultural studies. Yet culture is not without its value to an engineer. To attract clients in the first place, and afterward to induce them to place their bank accounts at the disposal of the engineer, may require all the tact and all the charm of personality that culture can bring or that is of use to the diplomat, lawyer or doctor. There are few cases like that of Winstanley, who financed his own enterprise for the benefit of mankind. More often is the engineer in the position of William Hood, who persuaded E. H. Harriman to spend the millions required for the construction of the Lucin cutoff.

It is evident that when an American engineer goes abroad for professional work, it is a great advantage to him to be able to speak the language of the country. For this reason there has been a tendency to substitute in the curriculum Spanish in place of French or German, a tendency which is to be regretted not only because Spanish is inferior as a means of mental discipline, but also because the Spanish engineering literature is comparatively insignificant.

When an American firm desires to copy European improvements in some type of machine, the desired information may be obtained in several ways. Sometimes complete working drawings are imported and are used in the American shops either with or without redrawing and changing the metric to English measures. Again, a representative may be sent to Europe or an expert imported from there. Except in the case of importing drawings, the ability to speak a foreign language is of great value to the American engineer. Some one with a knowledge of the language is selected to go abroad, or to receive instruction from the imported expert, and the engineer thus selected is in position to get information at first hand, and to become of increased value to his employers.

It may be objected that we have no need to go abroad for information; that American workmen lead the world, or, as one writer phrases it, "The best thoughts of the greatest men are available in English." I believe there is a mistaken patriotism in this kind of talk. Dr. J. A. L. Waddell, in an address delivered before the students of the Rose Polytechnic Institute in 1902, said:

> As a rule, the graduate engineer has no time to devote to the study of foreign languages; and it is questionable whether it be advisable to devote to them much time in the technical schools. The plea for their retention is that there are many good technical books in these languages that the student ought to be able to read. My reply to this is that there are more good technical books in the English language than a man can ever find time to study, and that all valuable technical works in foreign languages are soon translated into English. In my opinion a knowledge of French is only a gentlemanly accomplishment, and one that a man is very liable to lose for want of use, and a knowledge of German is of no advantage whatsoever to an American engineer.

This is surprising language indeed, coming as it does from one who, like Dr. Waddell, liberally adorns his writings with phrases from French, Spanish and Latin!

It seems to me that our attitude toward foreign languages is largely an inheritance from our English ancestors. An Englishman takes the position that what is good enough for him, is best for the rest of the world. When he goes to some half-civilized country he retains his language and his customs. He puts on his dress suit for dinner if there is not another dress suit within a hundred miles. A Frenchman under similar circumstances would be more likely to adopt the native customs and dress, and in a few years to become with difficulty distinguishable from a native. It is this attitude of mind

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that has made the English the best colonizers in the world; but it has not helped them in their export trade, and thus the Germans have been enabled, in recent years, to make great inroads on England's former commercial supremacy.

Our isolation, here in the United States, has helped us to maintain the English attitude. One can hardly take a day's journey in Europe without getting into a country where another language is spoken, so that in the ordinary course of events, either by traveling or meeting travelers, everyone hears foreign languages and realizes the advantage of understanding them.

It is a matter of common knowledge that for a number of years all the best automobiles were made in France. It may not be so well known, but it is equally true, that, at times at least, Europe has been ahead of the United States in the design of steam turbines, gas engines, hydraulic turbines, centrifugal pumps and gas turbines. Apart from correspondence and the methods already mentioned, American manufacturers had to obtain their information concerning these machines from printed books and periodicals.

It is true that there are more books in English than anyone can read, but it is quality, not quantity, that counts. If one cannot find in English the information he wants, he must either read it in a foreign language, or wait for a translation, and this brings us to a consideration of the importance of obtaining information promptly.

Suppose an automobile manufacturer in the United States finds his business seriously falling off on account of the increasing use of aëroplanes, and he proposes to start building the latter. He hears that a description of a Gnome motor, which he needs, has been published in a foreign language, perhaps in the patent specifications. How long can he afford to wait for a translation? While he is waiting, some rival who understands the foreign language may be going ahead and putting his goods on the market, and long before the translation appears, may become so firmly established as a builder of aëroplanes that our non-linguistic friend has no chance to enter the business.

If it is objected that a manufacturer could hire some foreigner to make a translation, it may be answered that it takes more than a mere linguist to make translations of engineering subjects. Even the best translations obtainable, made by engineers well versed in the language, are not as reliable as the originals. Anyone who has seen an article first in manuscript and again in proof realizes the possibilities of error in the printed page, and the probability of error is greatly increased in the case of translations.

One of the greatest difficulties is in changing formulas from metric to English units. So great in fact, is this difficulty, and so frequently have I found mistakes in the best translations, that I prefer, when possible, to take the original formula and make the necessary calculations using the metric measures. It should be noted that the fact that foreign articles are translated does not make it unnecessary for engineers to know foreign languages; on the contrary, it creates a special demand for engineers to do the work of translation.

The engineer who uses a translation has as his competitor every engineer who can read English. One who is his own translator, or rather, who reads and understands the foreign language without translation, narrows down to those who can do likewise, the number of competitors who can compete with him on equal terms, and his chances are much improved of being among the first to acquire any new and desirable bit of information.

To illustrate the rapidity, or lack of it, with which translations are made, some concrete examples will be given of books which are probably the best in their respective fields. In machine design, "Der Konstrukteur," by Reuleaux, appeared in the fourth German edition in 1889 and was translated into English in 1893. A book on internal-combustion engines which also waited four years for a translator was the second (1905) edition of Güldner's "Entwerfen und Berechnen der Verbrennungsmotoren." "Die Dampfturbine," by Stodola, appeared in the second German edition in 1904 and was translated in 1905.

At first sight it might appear as if the English-speaking steam-turbine designers were especially fortunate in the promptness of translation, but "Die Dampfturbine" has now reached a fourth (1910) German edition, greatly enlarged and improved, of which there is no translation. On hydraulic turbines, "Pfarr's Die Turbinen für Wasserkraftbau" has never been translated, although the first German edition was published in 1907, and the second in 1912. The list might be extended indefinitely, but the above should suffice to show that a manufacturer who did not have to wait for a translation would have a good start over his competitors.

To show that the Germans do not have a complete monopoly of pioneer work, mention might be made of Maurice d'Ocagne's "Traité de Nomographie, 1899," which has never been translated, though extracts from it begin to appear in American books on graphical methods of calculation. Gustav Herrmann's work on the graphical statics of mechanism, originally written in German and translated first into French and later into English, will serve to point out that one may sometimes have access to a book through a translation, when the translation itself is in a foreign language. Works in Italian, Swedish, Russian or any other language not ordinarily studied by American engineers, may usually be read in French or German before a translation into English has been made.

There is a question as to whether French or German is the more desirable. In the *Bulletin* of the Society for the Promotion of Engineering Education, 1908, p. 136, Prof. A. S. Wright tells of putting the following question to a number of engineers: "Which foreign language is of most value to the engineer, and why?" Out of 88 answers, 61 favored German. Prof. Wright comes to the conclusion "that the Germans are so far in advance in research work and so prominent in the practical application of their results that their language should be given the first place."

For special subjects or at certain times, French or some other language may become of prime importance. At one time Francis was doing research work in water measurement in the United States, and at another time it was Bazin in France. At one time Arinengaud and Lemale were working on the gas turbine in France, and the latest work seems to have been done by Holzwarth in Germany. Perfecting an invention is a slow process, and it may take the work of many men of various nations before the machine arrives at such a state of perfection

that further substantial improvement seems improbable.

It may be a matter of mere chance, and not of prior invention, that determines in what language the latest information on a subject may be obtained. Sulzer of Switzerland or Rateau of France might have written comprehensive books on centrifugal pumps, but they being too busy with commercial affairs, what seems to be the best book on the subject was written by a German, Fr. Neumann.

The German periodicals, as a general rule, are of more value to the designer than anything that can be obtained in English, and this is of special importance because information usually appears in periodicals before it is available in books. We have, to be sure, plenty of trade papers, as for example, the *Valve World*, *Reactions* and the *Universal Bulletin*, and plenty of publications that deal with popular subjects like automobiles and aëronautics, but with few exceptions such periodicals are of little use to the designer. It would be difficult to name two English or American journals of as much value to a specialist in a limited field as are, for example, *Die Turbine* and the *Zeitschrift für das gesamte Turbinenwesen*.

The most usual process by which a new idea becomes generally available is somewhat as follows. Some engineer has an idea, and as it seems important to him, he writes a paper about it and presents it before some local society which, perhaps, publishes the article. If the paper is reprinted by some periodical of wider circulation, it then becomes accessible to the writers of books, who may then, by references or extracts, render the material available to anyone who can read the language. All this takes time, and if the article is published abroad, additional time is consumed between the publication and the translation of the book. The engineer who can read the foreign periodical as soon as the mails can carry it to him, has a long start over the one who must wait until the material is available in English.

When one starts in to advocate a change in the engineering curriculum, he is always reminded that the curriculum is overcrowded and that we need to drop subjects rather than to seek after new ones. Unfortunately, every school has a different curriculum, so that no general solution can be suggested to relieve overcrowding and permit the introduction or retention of German. But in the last analysis, the amount of time available in college depends on two things, the number of years which a man can afford to spend on his education, and the training which he receives in the preparatory school. There is a limit to the amount that can be learned in four years, and while every school is ambitious to graduate students who can compete on equal terms with the graduates of the best institutions, it is not always realized that, other things being equal, the ability of the student at graduation is proportional to his ability at entrance. If the majority of instructors agree that every engineer should have a working knowledge of German, the logical thing would seem to be to require German for admission, if, as seems to be the case, there is not time enough in the college course for the necessary strictly technical studies and a thorough study of languages in addition.

If it is impracticable to require German for admission (and this, like other changes in the curriculum, is largely a local issue), other means might be adopted to provide the student with the desired knowledge of German. I hesitate to say that German is of more use to an engineer than calculus; but let us examine the proposition. The mind seems to be so constituted that one cannot recall something unless the attempt is made to recall it about once in so often. This is not saying that the mind does not retain the subject, which is something different. A subject once learned may be relearned with greater ease, even if it has been, as we say, completely forgotten. But the value of a certain kind of knowledge may often be judged like that of a mechanical calculator. If the device is so complicated, or is used so infrequently that the directions have to be consulted every time it is used, the chances are that one could make quicker progress without it.

It is claimed that the study of foreign languages is a waste of time in technical schools because the majority of students forget them after graduation. The same might be said of calculus, and the question arises whether forgetting is due to bad methods of teaching or to infrequency of use of the subject. The latter is the case with calculus. It can be used most often in determining maxima and minima; but such problems may be solved nearly as quickly by the tentative method, combined with a little intelligent guessing, which is indeed a quicker method than by calculus, if the engineer has to get out his old college textbook and try to brush up his somewhat hazy recollections of the subject. Problems in integration are either too complicated to be solved by analytical methods except by the most expert mathematicians, or else they are so simple as to have been solved long ago, with the results available in tables for any engineer. Engineers as a rule are not expert mathematicians, as was noted by Trautwine, whose remarks on the subject are well worth occasional reading.

It must be admitted that calculus is used to such an extent in engineering books that it is a great handicap to the understanding of many authors if one has never studied the subject. Without a thorough knowledge of calculus, the student may be seized with dread every time he encounters a $dx$ or an integration sign, or at least he must pay less attention to the ideas of the author than to the medium through which they are conveyed.

The graduate engineer is in much greater danger of forgetting calculus than languages on account of the more frequent opportunity to use the latter. Furthermore, means may be more readily provided for increasing the use of foreign languages than for extending the use of calculus. The use of textbooks in French and German is a good method of impressing students with the utility of foreign languages. In fact, in some advanced subjects, especially chemistry, the difficulty of obtaining suitable textbooks in English is so great that many instructors use German texts merely for the sake of learning the subject, without any regard whatsoever to the value of German as a byproduct.

A book which could be used with profit by all engineers, because it has no equal in the English language, is the German engineers' pocketbook, "Hütte." It is a common saying that it is worth while to learn Italian for the sake of reading Dante in the original. One could say equally well that it is worth while to learn German for the sake of using "Hütte" in the original, especially since it must be used in the original or not at all. The habit of referring to that book, once acquired in college, would be retained through life.

It is not uncommon for engineering mathematics to be taught by instructors in the department of technology, rather than by those in the faculty of arts and sciences, because it is realized that there is a difference in emphasis, if not in substance, between the subject when taught as a pure science, and when taught with regard to its future application to engineering. A similar distinction holds good in the case of languages, between the proper methods of instruction with a view to their literary value, and the manner in which they should be taught with a view to their future use as an instrument for acquiring scientific knowledge.

In at least one institution, the University of Michigan, the modern language work of engineering students is entirely separate from the literary department. It is quite possible, however, that the rudiments of the languages, say one year of French and two of German, could be taken care of about as well by the faculty of arts and sciences, letting the student then take an additional year in reading scientific literature with an instructor under charge of the department of technology. After such a preparation as this, and the judicious use of foreign textbooks in advanced classes, the student should have so lost the dread of foreign books that he would naturally continue their use after graduation. An incidental advantage of foreign books is their low cost, since they may be imported free of duty. An engineer has been defined as a man who does for one dollar what anyone could do for two, and according to this, a man who, by his knowledge of foreign languages was able to get better information at less cost, would be the better engineer.

One objection to modern languages as now taught is that the students get a smattering of French and German, but do not learn enough of either language to be of practical use. It might be well worth while to consider whether it would not be of much greater value to a graduate to know German well, than to have a slight acquaintance with two or three foreign languages. If so, time for German could, as a last resort, be obtained by dropping French, both as an entrance requirement and as a prescribed study in college.

To sum up the conclusions we have reached, the chief value of modern languages to an engineer is as a means of properly obtaining the latest information on the subject he has at hand, and for this purpose, on account of the technical position of the Germans, their language is to be preferred. If, on account of a crowded curriculum, it seems impossible to teach German long enough in college to give the student a working knowledge of the subject, it should be placed among the entrance requirements, or room should be made for it in the college curriculum by omitting something else, even, if absolutely necessary, by discontinuing the study of French.

**A Year's Output of European Shipyards**—What appears to be a record in marine engineering has been created by Messrs. John Brown & &Co., who during 1912 have constructed machinery of 178,500 i.hp. for seven vessels. So far as is known, there are not likely to be any figures this year to equal these. Engines of over 121,000 i.hp. have been built by Messrs. Krupp for nine vessels, and the North-Eastern Marine Engineering Co. constructed, in their Wallsend and Sunderland shops, machinery of over 129,000 i.hp. for 60 mercantile steamers. The highest figures for the world last year were those of the Vulcan Co., of Hamburg and Stettin, who constructed engines of 166,230 i.hp. for ten vessels, and this year the highest Continental figure is likely to be that of the Schichau yards at Elbing and Danzig, where machinery of over 143,000 i.hp. has been built. —"London Times," Dec. 18.

## A Spring-clamp Rail-brace

A new form of combined rail-brace and tie-plate now being introduced has the special feature of exerting a spring or clamping grip on the rail base. This gives a more effective hold than when the edge of the rail base is simply fitted to a recess in a rigid rail-brace. It has another special feature in the use of screw-spikes as fastenings, the spikes serving to grip the brace to the rail as well as to hold the brace in position. The clamp shown

SPRING-CLAMP RAIL-BRACE GRIPPING THE RAIL BASE BY MEANS OF SCREW-SPIKES
(Robert D. Townsend, Inventor, Chicago)

in the cut is made from ⅜-in. steel plate, one end being first stamped to shape to form the rail-brace and being then bent over upon the flat portion which forms the tie-plate; the width is 7 in. The rail head has a good bearing against the top of the brace, which transmits the pressure to the base plate and the tie. The plate is punched with holes for four screw-spikes, and it will be seen that the outer spikes are close to the rail base and pass through both the upper and lower portions of the plate, so that as the spikes are screwed home, the upper portion (with the brace) is brought down firmly upon the foot of the rail. For locations where rail renewals are frequent and traffic is heavy (so that little time is available for renewals), ordinary spikes may be used on the inside, as they are more quickly removed to allow of slipping the old rail out as soon as the two outside clamping screw-spikes have been slackened. The design as shown in the cut is for use on curves, but another form is used as a combined rail-brace and slide-plate at switches, the flat portion being long enough to carry both the stock rail and switch rail.

About 200 of these rail-braces have been in use for nearly six months on four sharp curves of the Chicago Junction Ry., a terminal line whose tracks carry very heavy traffic and heavy yard and road engines. We are informed that previous to their use it was necessary for the section gangs to attend to these curves twice a week, but that no work on the outside rails (held by the new braces) has been necessary since the braces were placed, as the rails hold their position on the ties in spite of the severe conditions of service. The braces are not yet applied to the inside rails. The rails weigh 80 lb. per yd., and there are five braces to each rail, held by screw-spikes ⅞x6 in. This device is patented, and is the invention of Robert D. Townsend, of 5821 Michigan Ave., Chicago.

**A Competition for a Machine for Cutting Forest Undergrowth** has been announced by the Societe des Agriculteurs de France, in connection with its annual agricultural competition in 1913 and 1914.

# Some Experiences with Concrete Piles in Chicago

By J. Norman Jensen*

It seems on the face of it that a concrete pile ought to be an ideal form of foundation. Concrete itself is permanent, increases in strength with age, is employed to the best advantage in compression, and is unaffected by the lack or presence of moisture. In case of the lowering of the water line of a city due to the construction of subways, sewers, and other forms of deep excavation, involving, as it does, grave danger to a wooden pile, the integrity of a concrete pile should be unquestioned.

In the city of Chicago the advantages above enumerated and the increasing cost of wood piling led to the adoption of the concrete pile in the foundations of various buildings. While in some cases the piles were entirely satisfactory, in other cases the results attained were such as to cast suspicion on some forms of the concrete pile, especially when driven under adverse soil conditions.

Some of the experiences with three different forms of concrete pile are given below. The observations for each type are designated by the headings Pile Nos. 1, 2 and 3.

## Pile No. 1

About four years ago piles were driven for the foundation of a building located on 22d and La Salle Sts. These piles were 21 ft. long, 20 in. in diameter at the top, and 6 in. at the point. In constructing these piles a steel shell was driven to the required depth by means of a collapsible steel core. This core was then withdrawn and the steel shell filled with concrete. The shell was

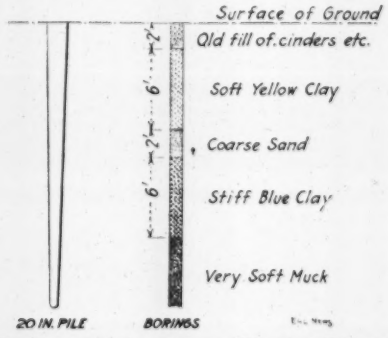


Fig. 1. Boring in Location Where Pressure Was Sufficient to Crush Pile Casings

built in three sections provided with suitable joints to keep out water and dirt.

The steel shell or casing was at first built of No. 20 gage steel. As the work progressed it was found that this thickness of metal was not sufficient to prevent the collapsing of the casing, and it was found necessary to increase the thickness of the casing until at the end of the work No. 16 gage was used.

A record of the borings on the site, and the location of the concrete pile in the soil is given in the accompanying sketch (Fig. 1). Each pile was examined before filling with concrete by dropping a lighted paper into the casing or by reflecting sunlight into it by means of a mirror. In a great many cases the section of the casing in the soft muck collapsed while the inspector was watching it, and water was forced in between the lock joints of the casing. In such cases another casing would be driven, and another, if necessary, until a shell was obtained which would withstand the earth pressure. Even when the No. 16 gage casing was used, the concrete which had completely filled the shell to the top would rise as much as ½ in. over the top of the shell, indicating that there was still a tendency to collapse the shell. When it is considered that a cylinder is especially adapted to withstand pressures of this kind, it is seen that the lateral pressure on the pile must have been very great.

As stated in the above paragraph any shell that showed signs of collapsing was reinforced with another shell driven within the first. In this way a shell and pile were obtained satisfactory to both the architect and the building department.

## Pile No. 2

Recently a new form of concrete pile was driven for the foundation of a church located at 29th and Quinn Sts. A heavy steel casing and core were driven to rock. This core fits inside of the casing, and is provided with a steel point at the lower end and an enlarged head at the upper. The point projects about 4 ft. below the bottom of the casing. The enlarged head fits over the top of the casing and transmits the blow from the hammer to the casing. After the rock was reached the core was removed and concrete dumped into the hole formed by the steel point. The core was then lowered, and used to ram the concrete. More concrete was dumped in and the ramming process continued until an enlarged base of the pile was formed. The casing was then filled with concrete to the top. When the casing was filled it was withdrawn from the ground.

As required by City Ordinance, test loads were placed on several piles. A platform 12x12 ft. was loaded with sand to twice the working load, and readings of the settlement taken with an engineer's level. In some cases there was as much as 6½ in. settlement when the load of 40 tons had been on for 24 hr.

It was decided to investigate the cause of the failure. A pit was dug around the piles which had been tested, and the piles completely uncovered. These piles had been driven through about 14 ft. of an old fill, and then through about 9 ft. of medium soft clay. Directly under this clay was a smooth rock, the bed of an old quarry.

On uncovering this pile it was found that the shaft of the pile was in very good condition to about 4 ft. from the rock. At this point the pile was supposed to be formed into a large bulb or base. The base was formed all right, but the space between the base and the shaft had been squeezed into a core about 6 in. diameter. It was at this contracted portion that the pile had failed.

Although the pile had failed, the test showed that it could carry some load in spite of its contracted section. Because of the necessity for an early completion of the building it was decided to require the driving of a great many additional piles, so as to bring the load on each pile within safe limits. It seemed the only solution of a bad situation.

It was claimed that this type of pile was still in an experimental stage, and that the foreman on the job had

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not driven the piles in accordance with the instructions given him. To support this claim, three additional piles were driven on the job, by another superintendent, in exact conformity with the building ordinance. When the concrete was about five weeks old, one of the piles was tested with a load of 60 tons. The total settlement was 0.02 of a foot after the full load had been on for 48 hours. The total settlement allowed by the ordinance for this load would have been 0.05 of a foot. This last test was satisfactory, and in full compliance with the ordinance.

### Pile No. 3

Perhaps the worst failure of a concrete pile which has occurred in Chicago was that of the foundations of a building located on 5th Ave., near Van Buren St. A single row of piles 16 in. in diameter was driven to support a line wall. These piles were formed by driving a straight shell of considerable thickness to the required depth. This pile was provided with a cast-iron shoe. Concrete was poured into the shell after the driving had ceased, and the shell was raised slightly. This was continued until the hole in the ground left by the shell was completely filled with concrete.

Signs of failure occurred when the building was in the early stages of construction. When the roof was on, these evidences of settling became so alarming that a new type of foundation was decided upon.

Concrete caissons were sunk beneath the party wall. As these caissons were sunk a careful record was made of the position and size of the concrete piles which were uncovered as the excavation for the well progressed. The condition in which the piles were found is given in Fig. 2.

The upper part of the drawing represents a plan of the piles which had been driven, and also the caissons which were sunk afterward. An elevation of four of the caissons is given showing the positions of the concrete piles with reference to the caissons. At various levels the positions of the piles in plan is also shown. The typical borings showing the character of the soil are given, drawn to the same scale as the rest of the plan.

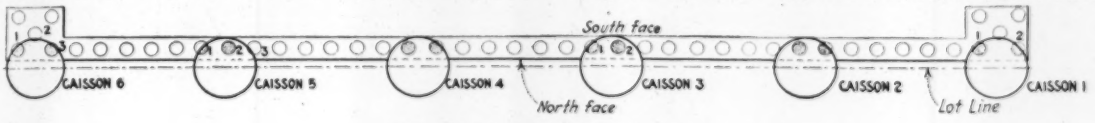
It was plainly evident why every sill in the building was out of level and badly cracked. It required no expert knowledge to see why the floors had tilted to ar alarming angle. Some of the piles had been squeezed into such a small section that there was very little left. In some cases the pile would be discontinuous, as there would be a space of 5 or 6 ft. where the dirt had replaced the concrete. None of the piles were straight or plumb in either direction, as can be seen in the elevations and plans at different levels.

### City Ordinances

The City Ordinances in regard to concrete piles read as follows:

531. **Concrete Piles Allowable—Compression Tests—How Made.** (a) Where concrete piles are used, test piles shall be driven and loaded under the general direction of the Commissioner of Buildings.

(b) The allowable compression on concrete piles shall not




PLAN OF CONCRETE PILES AND CAISSONS

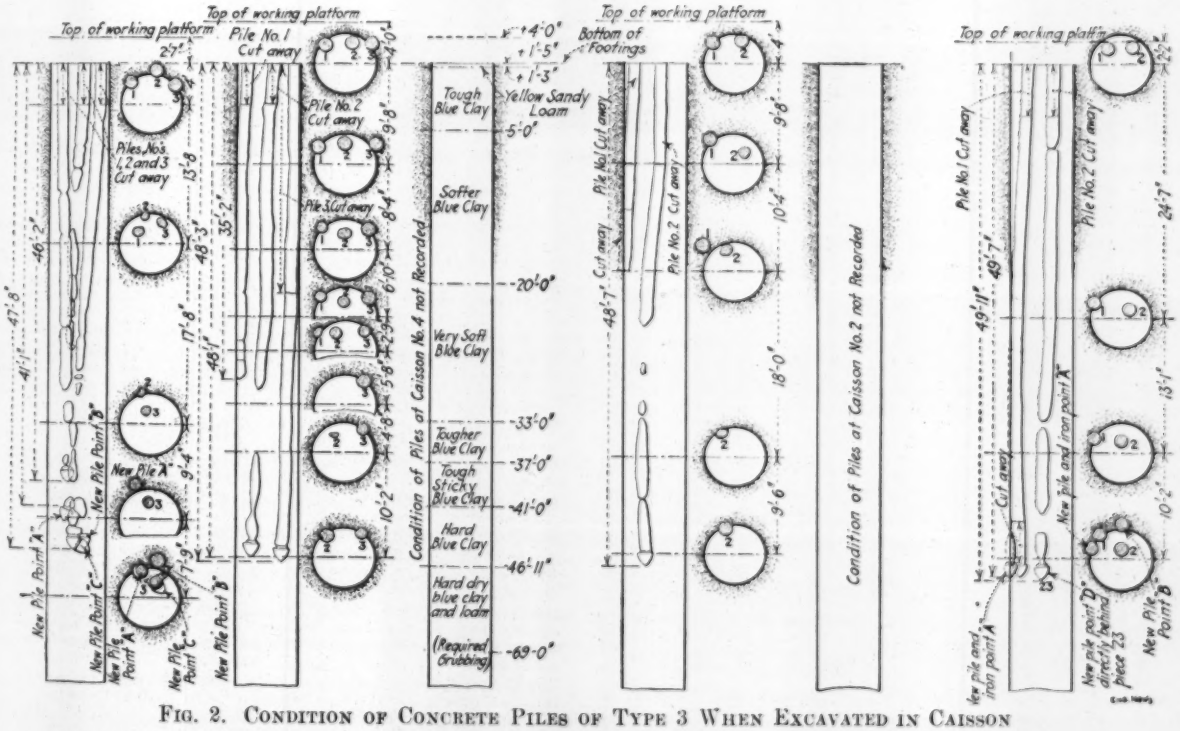

Top of working platform
Pile No. 1 Cut away
Pile No. 2 Cut away
Pile No. 3 Cut away
Piles Nos. 1, 2 and 3 Cut away
Tough Blue Clay
Yellow Sandy Loam
Softer Blue Clay
Very Soft Blue Clay
Tougher Blue Clay
Tough Sticky Blue Clay
Hard Blue Clay
Hard dry blue clay and loam
(Required Grubbing)
Condition of Piles at Caisson No. 4 not Recorded
Bottom of Footings
Condition of Piles at Caisson No. 2 not Recorded
New Pile Point A
New Pile Point B
New Pile Point C
New Pile Point D
New pile and iron point A
New pile point D directly behind piece 23

FIG. 2. CONDITION OF CONCRETE PILES OF TYPE 3 WHEN EXCAVATED IN CAISSON

exceed 400 lb. per sq.in. at a section 6 ft. from the surface of the ground in immediate contact with the pile.

(c) These tests shall conform to the following regulations: Tests shall be made on at least two piles in different locations and as directed by the Commissioner of Buildings. Not less than three piles to be driven for each test. The pile to be loaded to be driven first, the second pile to be driven within six hours of the driving of the first, the third pile to be driven within 20 to 24 hours after the first. The two latter shall each be driven with centers not to exceed twice the greatest diameter of pile, from the center of the test pile.

(d) The tests shall not be started until at least ten days after the piles to be loaded are driven, except that piles that have been cast and set up before driving may be tested as soon as practicable after driving. The piles shall be loaded with twice the proposed carrying load of the piles.

(e) The settlement shall be measured daily until 24 hours shows no settlement.

(f) One-half of the test load shall be allowed for the carrying load, if the test shows no settlement for 24 hours and the total settlement has not exceeded 0.01 in. multiplied by the test load in tons.

The Department of Buildings has taken the stand that any concrete pile which does not show good workmanship able for use in the City of Chicago.

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[In accordance with a rule of long standing on ENGINEERING NEWS, proofs of the above contribution were submitted to the several concerns controlling the above mentioned types of concrete piles, and an opportunity was afforded them to present a statement regarding the above described tests in the same issue. We append the letters submitted in reply.—ED. ENG. NEWS.]

Sir—Referring to Pile No. 1 in Mr. Jensen's article, all engineers familiar with concrete piling will immediately recognize this as the Raymond pile. Since the work mentioned was done, the Raymond Concrete Pile Co. has developed a light sheet-steel shell, spirally reinforced by means of No. 1 to No. 3 hard-drawn wire, which is grooved into corrugations in the shell. This makes a remarkably strong form which is capable of resisting any back pressure encountered, and which remains in the ground.

H. R. MOYER,
Raymond Concrete Pile Co.
140 Cedar St., New York City.

Sir—Mr. Jensen's article calls for some discussion and comment, especially from those engineers who, like myself, have devoted a great part of their practice to the study and execution of concrete-pile foundations. This article is well calculated to create an erroneous impression regarding this general type of construction, because it devotes much space to unsuccessful tests, but dismisses successful ones (made under the same conditions and on the same site), with a few words. Also because it says nothing at all about the thousands of concrete-pile foundations in Chicago and elsewhere which have been installed with great economy and absolute satisfaction. Concrete-pile construction is too old, too economical and too thoroughly tried out for any question to arise as to its reliability or desirability. And let it here be affirmed that the percentage of concrete-pile failures in this country is as small as or smaller than that of any other form of engineering construction.

In speaking of Pile No. 2, Mr. Jensen should have stated that after the first test was made, the strength of the foundation was increased by the addition of 85 more piles. Work on the superstructure was then allowed to proceed by the City Department, and the building now stands practically complete. It should be mentioned in this connection that the company which installed these piles has completed, to the satisfaction of the owners and the engineers, this and every other foundation contract that it has ever undertaken.

The second tests made on this pile were not required by the Building Department, but were made by the contractors on their own initiative. When the load was taken off this pile, the top of it rose 0.01 ft., showing that the actual settlement was only 0.01 ft. The allowable settlement under this load is 0.06 ft.

Mr. Jensen's article is apt to create a false impression in his description of the pile which was excavated. This pile was one of the piles driven adjacent to the test pile proper. Its purpose was merely to see whether any damage would occur to the test pile itself upon the driving of an adjoining pile, and was not intended or expected to receive any load.

In conclusion it should be stated that Pile No. 2 is fully approved by the Building Department of Chicago for future work, provided it complies, as must all other types of pile construction, with the test-pile requirements as specified in Paragraph 531 of the Building Ordinance, as given at the end of Mr. Jensen's article.

HUNLEY ABBOTT,
McArthur Pile & Foundation Co.
11 Pine St., New York City.

**The Engineering of Management**—The most difficult of all problems which beset the young engineer is the management of men. There are certain occupations in which a man can design and complete his work himself. The painter, the littérateur, the musician can labor in solitude, and their products are the fruit of their own brains. But with the managing engineer the case is quite different. He has largely to see through other persons' eyes, to hear through their ears, and to act through their hands. The day is not long enough for him to take personal cognizance of everything for which he is responsible. He must act to a great extent through subordinates. When they serve him well he gets the credit, and when they serve him ill he bears the blame.

It is therefore of immense importance to him, and the firm he represents, that he should, in the first place, select his assistants with skill; and, in the second, imbue them with a spirit of loyalty. Nothing conduces more to good service than the knowledge among the rank and file that the chief can take any job out of their hands and do it as well as or better than themselves.

In early years this state of affairs is quite possible, but later, as the province under a man's control widens, he can no longer be an adept in every department. Then his method of influencing those below him must be moral and intellectual rather than technical. He must be a student of character, able to discern both the strong and the weak parts of his assistants. He must encourage the diffident, stimulate the lethargic, and repress the erratic. There are no books that explain how this is to be done, and no professors who lecture upon the art. It can only be acquired by constant effort, and the effort must be begun in early years, long before the engineer has much opportunity of putting the lessons into practice.

A review of the careers of the great men of the world shows that they were always surrounded by capable assistants of their own choosing, and he who hopes to rise to a post of great responsibility must practice the study of character with assiduity while able to be on familiar terms with his fellows. As one grows older, a veil gathers between one and one's acquaintances. There is no longer the easy familiarity of earlier years. It is not possible to gaze into the depths of their dispositions with the ease of former days; opportunities of studying human nature are gradually curtailed. The foundations of the knowledge of character must be laid early in life.

[Extract from the presidential address of Sir A. Trevor Dawson to the Junior Institution of Engineers, London, England, Dec. 11, 1912.]

# Chlorinating Plants, Croton Water Supply

By T. D. L. Coffin*

*SYNOPSIS—Operating results of a temporary plant, which treated with hypochlorite of lime more than 100 billion gallons of Croton water for New York City in 1912, are given. A permanent hypochlorite or chlorinating plant, to treat the flow through both the old and the new Croton aqueducts, is described and fully illustrated. Brief descriptions are given of four other chlorination plants in the Croton drainage area: Three to treat the waters of tributaries of the Croton before it reaches the main supply and one to treat another tributary and a part of the sewage of the village of Brewster, N. Y.*

In June, 1910, I. M. de Varona, chief engineer of the Department of Water Supply, Gas and Electricity of the City of New York, made trials of hypochlorite treatment in connection with the Croton water-supply. The results were so satisfactory that its use has been extended until the city now maintains five of these plants: one on the New Aqueduct at Pocantico, treating the entire supply from the Croton, and the other four upon various tributaries of the reservoirs.

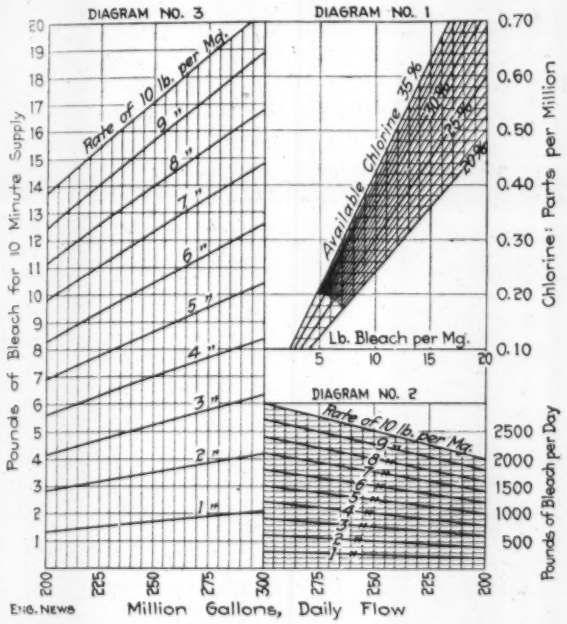


DIAGRAM NO. 3
DIAGRAM NO. 1
DIAGRAM NO. 2
Rate of 10 lb. per Mg.
Available Chlorine 35%
Lb. Bleach per Mg.
Pounds of Bleach for 10 Minute Supply
Chlorine: Parts per Million
Pounds of Bleach per Day
Million Gallons, Daily Flow
ENG. NEWS

Fig. 1. Diagrams for Determining Amount of Hypochlorite of Lime (Bleach) To Be Added to Croton Water-Supply for Varying Percentages of Available Chlorine and Different Daily Rates of Water Flow

*Assistant Engineer, New York City Department of Water Supply, Gas and Electricity, Katonah, N. Y.

The continuous treatment of the flow of the New Croton Aqueduct was commenced in June, 1911, the plant being located at Shaft No. 9, north of Tarrytown, N. Y., known as the Pocantico plant. It consists of a rough frame building which houses two cement-lined cypress tanks, 12 ft. in diameter and 6 ft. in height, and a constant-level feeding tank with adjustable orifice discharging through a manhole into the crown of the aqueduct. Within the aqueduct, there is suspended a wooden grid to secure a proper mixture of the chlorine solution and the flowing water. The operating floor is just above the solution tanks and in it are two screened mixing pits.

In operation, a drum of lime, weighing about 800 lb.,

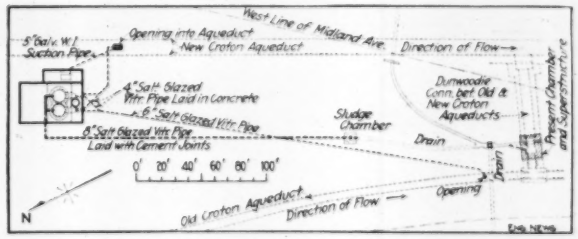



Fig. 2. Location of Permanent Chlorinating Plant for Croton Water-Supply, New York City

is rolled into position over a pit and the contents washed out into the pit by a hose stream under pressure. Enough "bleach" is dissolved to treat the aqueduct flow for 12 hours. The tank is then filled with water and stirred to assure the thorough absorption of the chlorine. Four men operate the plant, two on the day shift, making solution, and one on each of the night shifts, maintaining a constant, uniform flow of the solution.

Experience has shown the desirable amount of chlorine to be between 0.40 and 0.65 p.p.m. (parts per million). The lower amount is used in warm weather and when Croton Lake is near the highwater line. The amount is

OPERATION OF THE POCANTICO CHLORINATING PLANT FOR THE TREATMENT OF THE CROTON WATER-SUPPLY IN 1912.
(City of New York, Department of Water Supply, Gas and Electricity, Boroughs of Manhattan and the Bronx)

| Month | Cost of labor and hauling | Million gallons treated | Amount of bleach used: Pounds | Parts per million gallons: High | Low | Av. | Bacteria: Croton Lake: Agar—37°: Max* | Min.† | Av. | Bile 0.10 c.c. | Bile 1.0 c.c. | Bile 10.0 c.c. | 135th Street: Agar—37°: Max.* | Min.† | Av. | Bile 0.10 c.c. | Bile 1.0 c.c. | Bile 10.0 c.c. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | $559.00 | 7,630 | 97,412 | 0.50 | 0.40 | 0.47 | 105 | 17 | 45 | 19% | 50% | 96% | 429 | 22 | 113 | 0% | 6% | 68% |
| February | 452.50 | 8,684 | 88,282 | 0.52 | 0.15 | 0.44 | 888 | 10 | 249 | 18% | 41% | 77% | 426 | 10 | 107 | 3% | 28% | 65% |
| March | 519.00 | 9,085 | 95,956 | 0.51 | 0.39 | 0.47 | 884 | 65 | 353 | 21% | 71% | 96% | 314 | 48 | 170 | 6% | 61% | 93% |
| April | 449.00 | 8,173 | 95,152 | 0.51 | 0.23 | 0.47 | 338 | 35 | 112 | 0% | 38% | 96% | 117 | 36 | 60 | 0% | 14% | 77% |
| May | 403.00 | 8,430 | 100,668 | 0.48 | 0.46 | 0.47 | 182 | 20 | 59 | 0% | 12% | 67% | 44 | 17 | 26 | 0% | 0% | 13% |
| June | 344.00 | 7,713 | 95,688 | 0.48 | 0.45 | 0.46 | 104 | 12 | 41 | 0% | 10% | 47% | 277 | 11 | 69 | 0% | 0% | 23% |
| July | 486.00 | 8,941 | 102,672 | 0.47 | 0.46 | 0.46+ | 587 | 25 | 170 | 4% | 20% | 60% | 367 | 22 | 91 | 0% | 0% | 16% |
| August | 376.00 | 8,905 | 102,672 | 0.48 | 0.42 | 0.48 | 384 | 26 | 168 | 8% | 19% | 50% | 231 | 38 | 134 | 3% | 3% | 22% |
| September | 366.00 | 8,670 | 99,350 | 0.49 | 0.44 | 0.45 | 4480 | 31 | 1153 | 0% | 25% | 71% | 480 | 21 | 136 | 0% | 0% | 43% |
| October | 376.00 | 8,601 | 96,034 | 0.49 | 0.14 | 0.44 | 613 | 31 | 173 | 8% | 29% | 79% | 78 | 16 | 39 | 0% | 0% | 39% |
| November | 366.00 | 8,546 | 84,732 | 0.47 | 0.30 | 0.39 | 126 | 16 | 49 | 9% | 22% | 57% | 39 | 10 | 20 | 0% | 0% | 23% |
| December | 354.00 | 8,671 | 82,276 | 0.47 | 0.13 | 0.41 | 64 | 17 | 36 | 4% | 12.5% | 54% | 21 | 6 | 14 | 0% | 0% | 24% |
| | $5050.50 | 102,049 | 1,140,904 | | | 0.45 | | | 217 | 8% | 29% | 71% | | | 82 | 1% | 9% | 42% |

*Average of 5 highest counts
†Average of 5 lowest counts

| | |
|---|---|
| Cost of labor and hauling | $5,050.50 |
| Cost of chemical | 16,628.68 |
| | $21,679.18 |

Cost per million gallons ..... $0.2124

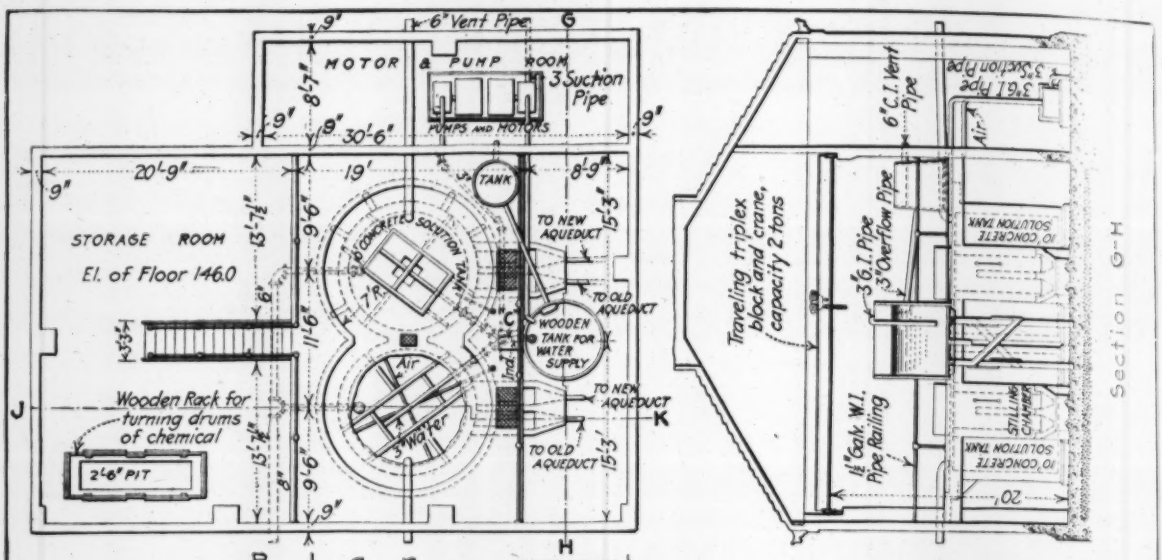



FIG. 3 - GENERAL PLAN AND SECTIONS

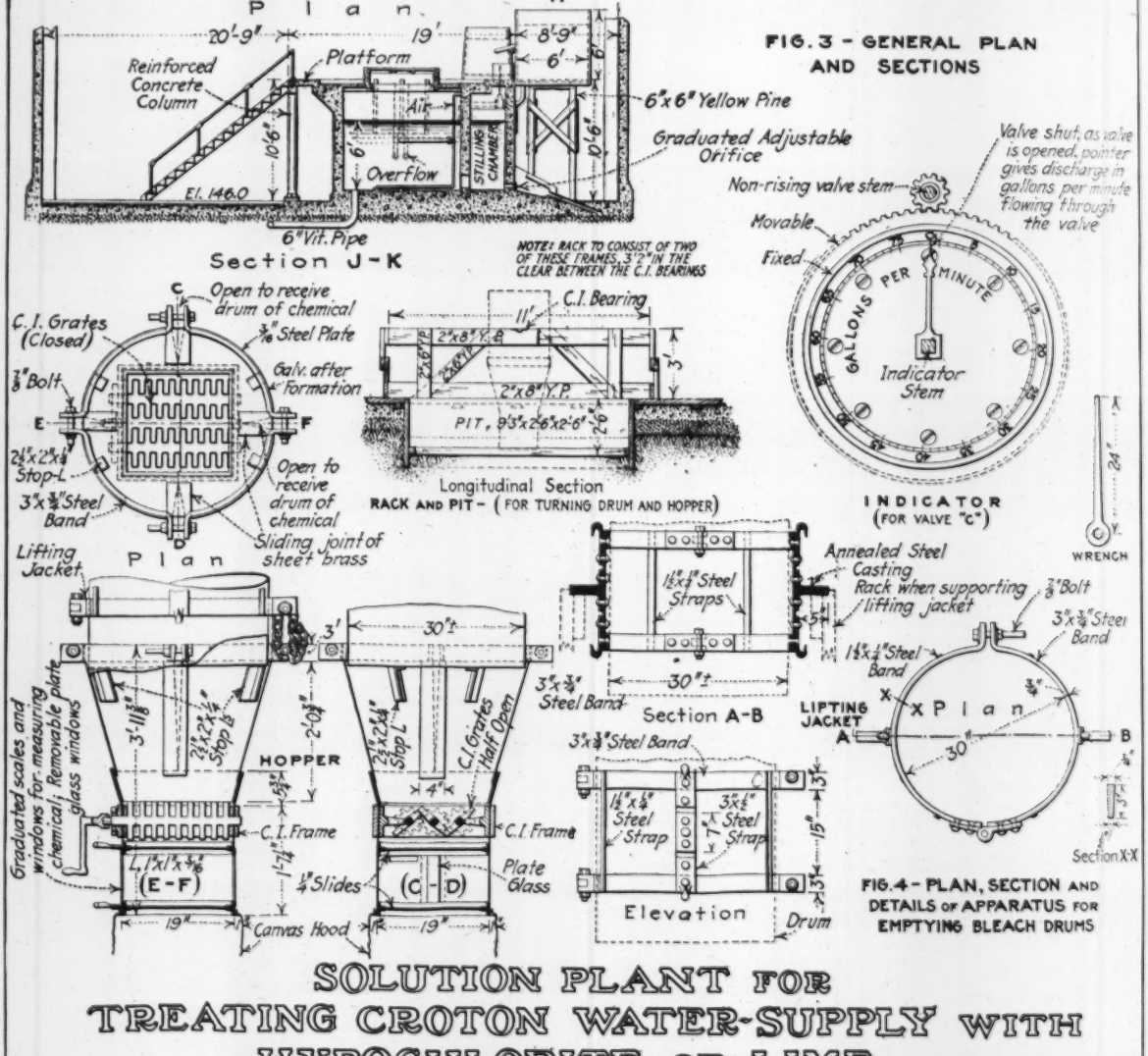



FIG. 4 - PLAN, SECTION AND DETAILS OF APPARATUS FOR EMPTYING BLEACH DRUMS

# SOLUTION PLANT FOR TREATING CROTON WATER-SUPPLY WITH HYPOCHLORITE OF LIME

gradually increased as the storage in Croton Lake drops or the temperature of the water approaches freezing. The amount of "bleach" to be used daily is determined from a chart (Fig. 1), which shows that the daily amount of chemical is about 4000 lb. Where so much chemical is used, the chart shows the economy resulting from varying the charge of "bleach" in accordance with the amount of its available chlorine, as determined by laboratory analysis.

The Pocantico plant is to be superseded shortly by a more detailed plant now nearing completion at Dunwoodie, Yonkers, N. Y. At Dunwoodie, the old and the new aqueducts (Fig. 2) are near each other and near the surface, affording the only site where the water carried by both aqueducts may be treated from a single plant. This, together with the facts that electric current may be had here as a source of power and that a freight station is near-by, determined the location of the new plant at this place.

This plant is designed for a maximum capacity of 400,000,000 gal. per day and is to be operated, as is the one at Pocantico, with such auxiliary parts as are necessary to continue the plant in constant operation should

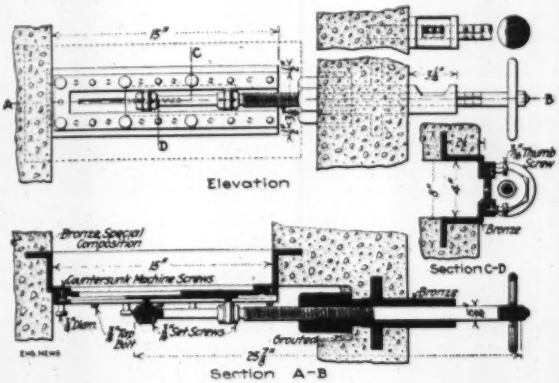



Fig. 5. Detail of Adjustable Orifice for Croton Hypochlorite Plant, New York Water-Supply

any part of one unit be undergoing repair, in which event the bleach will be dissolved at a fixed rate in a tank of solution maintained at a constant level, the water supplied and the solution discharged being identical in amount.

The general design of the Dunwoodie plant is shown by the plan and cross-sections, Fig. 3, while Figs. 4 to 6 show its details more fully. The main features are: apparatus for lifting and discharging the drums which contain the chloride of lime or "bleach"; two solution tanks, with dissolving cages and water jets, air-operated agitating pipes, and screened outlets; two solution-stilling chambers, provided with graduated discharge orifices; and water-supply tanks and various accessories. From the discharge orifices, pipe lines extend to connections with each aqueduct, where devices to be described later mix the solution with the water to be treated. These details will now be described.

To reduce to a minimum the escape of fumes, arrangements have been made whereby, after cutting the head out of a sheet-iron drum of bleach, its contents are not again exposed to the air. A metal lifting jacket (Fig. 4), which bolts about the drum, is provided with steel trunnions fitting into cast-iron bearing plates set in a wooden frame. By means of a two-ton crane, the jacketed drum is carried to the frame and rested with trunnions in the bearing plates. The top is then removed, a metal hopper clamped over the opened drum, and the drum revolved vertically. In this position, it is picked up by the crane and carried to the operating floor. The bottom of the hopper is formed by a cast-iron, hand-operated furnace grate, below which is a metal measuring box with gage. The operating floor forms the cover of each tank and is provided with an opening (Fig. 3) through which the desired amount of chemical may be passed from the measuring box into the solution screen, suspended within the tank just below the cover. The screen is made of steel structural shapes, galvanized after fabrication and covered with No. 11 bronze screening, $\frac{3}{8}$-in. mesh. Imemdiately below the screen is a 3-in. galvanized-iron water pipe, perforated to throw the water upward against the bleach within the screen.

The solution tanks, two in number (Fig. 3), are of reinforced concrete, 10 ft. in diameter and 9 ft. high. Beside the solution screen and the water-supply pipe mentioned, there is, in the bottom of each tank, a grid of 2-in. galvanized, perforated wrought-iron pipe, through which air under pressure will be forced, thereby securing a thorough mixture of the solution.

Sludge will be removed from the tanks through a 6-in. salt-glazed tile pipe, terminating at the tank bottom in a bronze screw-cap.

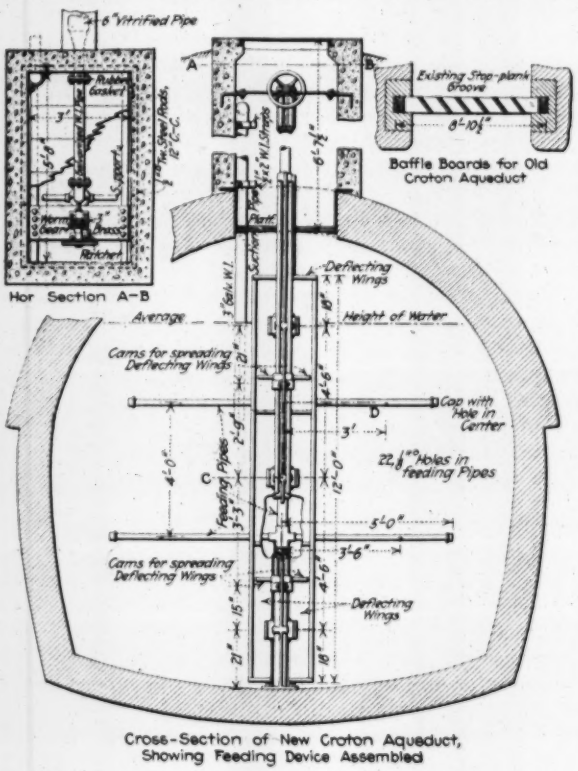
Each tank is provided with two bronze adjustable orifices (Fig. 5), one feeding the new and the other the old aqueduct. In order that the head upon these orifices may not fluctuate, due to the blowing of air through the solution, each orifice is set in a stilling chamber (Fig. 3), connected to the solution tank at its bottom by means of an opening covered with No. 16 bronze-wire screen of $\frac{3}{16}$-in. mesh.

Near the solution tanks are two elevated (Fig. 3) cypress tanks, into one of which water will be pumped from the aqueduct as a supply for the 3-in. pipe within the solution tanks. This water tank is provided with an overflow weir so placed that water is always delivered to the solution tank under a constant head of 7 ft. 9 in., the desired rate of flow being secured by an indicator valve graduated to read in gallons per minute. The second tank, receiving the overflow from the first, will afford the general water-supply for the plant.

The solution discharged from the regulating orifices will be carried to the aqueducts in 6-in. salt-glazed tile pipe, and at the old aqueduct will discharge through a 2-in. galvanized-iron perforated pipe extending vertically into the aqueduct. Below the point of application will be placed two wooden baffles (see plan, in Fig. 6) to deflect the flowing water and aid in securing a uniform mixture. The chlorine solution will be discharged into the new aqueduct (Fig. 6) by a perforated, 3-in. wrought-iron pipe, extending vertically into the aqueduct and equipped with four horizontal, perforated arms, so that the solution enters the flowing water from 22 orifices. In order that a most thorough mixture may be obtained immediately, a vertical-winged metal baffle is attached to the vertical solution pipe in the shape of a wedge. Each wing of this baffle is hinged so that, by means of cams actuated by a worm and hand-wheel from above, the spread of the baffle may be varied. By this means eddies

will be formed and the water flowing near the center of the aqueduct will be forced to the sides and the desired mixing secured.

The Dunwoodie plant will be housed in a reinforced-concrete building, having tool-picked exterior walls, relieved by smooth-dressed sills, lintels, corner blocks and cornice and surmounted by a red-tile roof and ventilating skylight. The building will be divided by a solid



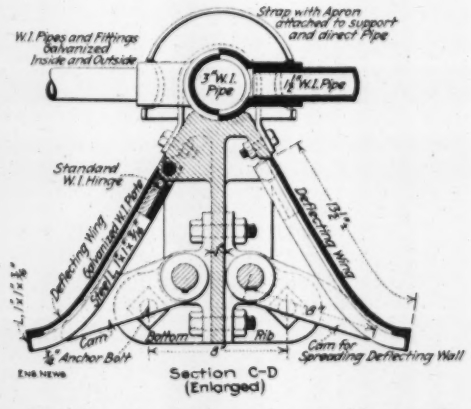




FIG. 6. DEVICES FOR ADMITTING AND MIXING BLEACH SOLUTIONS AT OLD AND NEW CROTON AQUEDUCTS, NEW YORK WATER-SUPPLY

concrete wall, into a machinery room, 8 ft. 7 in. by 30 ft. 6 in., containing the necessary pumps, motors, blowers and machinery to operate the station, and a storage and operating room, 30 ft. 6 in. by 48 ft. 6 in., with a clear height from floor to underside of crane of 20 ft. Of this space, the tanks and other apparatus require about one-half, the remainder being available for the storage of the "bleach." The contract for building this plant was given to L. J. Rice, at $13,720.

Within the Croton watershed, the Department of Water Supply maintains four chlorinating stations. The first one of these is on Kisco River, a tributary of Croton Lake, draining a populated district. Here it is found necessary to use between 1 and 2 p.p.m. of chlorine to produce satisfactory results. These amounts, in connection with those given for the Pocantico plant, indicate the effect of storage in reducing the organic content of Croton water. The maximum flood flow of the Kisco River, during the operation of this plant, has been 100,000,000 gal. per day.

At Brewster, N. Y., a chlorinating station has been equipped to take the place of the electrozone plant in treating a portion of the sewage of the Village of Brewster before delivering it to absorption beds, the change being made after the electrozone plant was destroyed by fire during the summer of 1911. The plant is similar to the one at Pocantico, except that it is used to chlorinate the flow of Tonetta Brook, a tributary flowing through the Village of Brewster, as well as to sterilize the village sewage. The stream flow may reach 50,000,000 gal. per day and the sewage flow 300,000 gal. daily. Sterile sewage effluents are secured by using about 15 p.p.m. and Tonetta Brook requires about the same amounts of chlorine as the Kisco River.

Two small plants, with a maximum capacity of 15,000,000 gal. a day, were completed during the past summer, one upon Katonah Brook, a tributary of Muscoot Reservoir, flowing through the Village of Katonah; the other at the outlet of Lake Glenida, a controlled natural lake whose watershed includes the Village of Carmel. These plants are duplicates in all essential parts and present no unusual features, other than the compact arrangement secured by the use of rectangular, reinforced-concrete tanks, the tops forming the operating floors. The plants have not been long enough in operation to state the amounts of chlorine required in treating these waters.

**The Necessity for State Supervision** of highway bridges is well illustrated by the following incident related by George H. Herrold, in a recent paper before the Civil Engineers' Society of St. Paul:

> The writer recently attended a bridge letting in an adjoining state. The experience is worthy of record, and replete with food for thought. Plans and proposals for ten reinforced-concrete bridges, with alternate plans for steel at four of the sites, were advertised for by the county commissioners. The specifications gave the span length, height and width of roadway, and called for a loading of 200 lb. per sq.ft., or a 20-ton road roller. Bidders were requested to visit the site of each bridge and submit a plan and a lump sum bid for the structure. On the appointed day, 15 bidders appeared at the county seat and submitted their plans and proposals before the hour of closing bids, 6 p.m. They were then informed that the bids would be opened next day. I do not wish to impugn for a moment the motive of these honest commissioners, but the visitors had the privilege of buying "eats, smokes and liquid refreshments" during the evening.
>
> The next morning the bids were opened; approximately 125 plans were submitted to those five honest farmers, who, assisted by the county surveyor, proceeded to analyze the plans and tabulate the bids. It was finally decided to let the concrete bridges to a local cement street paver, and the steel bridges to a relative of one of the county officers. The commissioners evidently decided that, as they knew nothing about the relative value of the plans, they would take a chance on men whom they knew, regardless of other considerations. The lowest bidder was informed that they did not like his plans.
>
> The bids ranged about as follows: A 24-ft. span reinforced-concrete bridge, $550 to $1228; a 40-ft. span, $835 to $2980; a 60-ft. span, $1175 to $3980. A number of the bidders submitted plans furnished by manufacturers of reinforcing. Some of the plans were excellent, and others were like the present-day millinery, fearfully and wonderfully designed. One bidder told me that a live load of 80 lb. per sq.ft. was good enough for designing any bridge. Another handed me his card; it read: "John Doe, Manufacturer of Cement Blocks," and written across the card in ink, for this special occasion, "and Reinforced Concrete Bridge Engineer."

# British Standards for Sewage Effluents

By W. L. Butcher*

The proposed standards for sewage effluents recently announced by the Royal Commission on Sewage Disposal and commented upon by Engineering News (see Dec. 19, 1912, p. 1159, and Jan. 9, 1913, pp. 76 and 79) are of great interest to sanitary engineers. Founded on exhaustive studies extending over many years they exhibit a rare use of practical "horse sense" reinforced by scientific facts. There may be differences of opinion as to their absolute value, but that they are founded and measured in the light of the best scientific knowledge of the present day, is unquestioned.

To American engineers the proposed standards seem quite stringent, and to those German sanitarians who maintain that fresh, swift moving, undiluted sewage is inoffensive if confined within proper channels, the standards must appear very rigid. It is but fair to say, however, that German sewages usually have to travel but short distances before entering large streams, whereas in England large cities and enormous industries are crowded together on small water courses. This only illustrates the impossibility of framing standards based on present scientific knowledge which will satisfy all conditions.

That they have intentionally set very rigid requirements appears to be recognized by the Commission, as it is said in their report that they realize that the application of any standard is in danger of becoming a leveling-down as well as a building-up process.

It is, nevertheless, of interest to examine, as far as such a thing is possible, what the requirements demanded would be if applied to American conditions. With regard to the so called "stringent standard" for works requiring the English "complete treatment"—settling, rapid filtration through sprinkling or contact beds and subsequent settlement of the effluent before discharge—American conditions have not as yet become such as to make this of much significance. It may be noted, however, that our largest works of the English character, those at Columbus, Ohio, judged by the last annual report of those works, would not measure up to the British standard.

The lower limit for discharge of sewage without complete treatment is placed at a dilution of 150 volumes, with the further requisite that the sewage shall not contain more than 6 parts per 100,000 of suspended matter, which latter the Commission states may be usually attained by chemical precipitation. As the flow of sewage from English communities is usually not much in excess of 30 gal. per capita per day, this standard may be restated, for comparative purposes, as being equivalent to about 7 cu.ft. per sec. per 1000 persons. Or still further, taking the average per capita flow of American sewage at 100 gal. this dilution factor, under American conditions, would become about 1 to 45.

For the discharge of ordinary settled sewage containing not over 15 parts per 100,000 of suspended matter, the Commission would require a dilution of 300 volumes, or reduced to similar American equivalents, 14 cu.ft. per sec. per 1000 persons, or 1 to 90.

In 1903, X. H. Goodnough, chief engineer of the Massachusetts State Board of Health, reported to the Committee on the Charles River Dam that, from an examination of the streams in Massachusetts, he was of the opinion that a nuisance never existed from the discharge of untreated sewage, when the flow was in excess of 6.5 ft. per sec. per 1000 persons contributing. The streams examined, moreover, were in general receiving unsettled sewage, so the suggested requirement of the Royal Commission is seen to be considerably more rigid than would be necessary to prevent a nuisance according to Massachusetts ideas. It should be explained, however, that the Commission, in fixing this limit, intended that there should be no "grey algæ growths in the streams, nor should there be injury to fish life."

The "legal dilution" in the Chicago drainage canal is fixed at 3.3 cu.ft. per sec. per 1000 persons, and recent reports show that nuisances plainly exist under these conditions, and further are probably largely caused by putrefying sludge banks, which emphasizes the great value of the low suspended matter in the effluent—6 parts and 15 parts per 100,000—imposed by the English standards.

The Commission makes rather an unsatisfactory, because highly empirical, attempt to determine what its standards would require in the way of dissolved oxygen content in the water, and arrives at the conclusion that the dissolved oxygen should never be allowed to fall below 4 c.c. per liter, which for fresh water at 65° F. would mean about 60%, and for average conditions as existing in New York Harbor, about 70% saturation. Many of the experts engaged by the New York Metropolitan Sewerage Commission to examine New York Harbor came to the conclusion that the waters would be satisfactory if the dissolved oxygen content were not allowed to fall below 50% saturation, and only one who, by the way, was an employee of the Royal Commission, thought that the limit should be placed at 70%. It is probably not too much to say that it would be extremely difficult to maintain the oxygen content at 70% saturation at all times in streams receiving appreciable amounts of crude sewage, excepting by the very efficient removal of suspended matter, as suggested.

With respect to New York Harbor and the Passaic Valley controversy, under the English standard, rigid as that is, it would probably be allowable to discharge the Passaic Valley sewage into the bay, without further treatment than settlement to reduce the suspended matter to 15 parts per 100,000.†

The economic value of such standards, if practical of enforcement, is illustrated by the two cases of Chicago and Pittsburgh. In the former, crude sewage is being discharged as by legal right up to a point far beyond that allowed by the English standard, while the Pennsylvania State Department of Health is attempting to force Pittsburgh to spend some $37,000,000 for purification works, according to estimates made by the city; although taking into account the local conditions at Pittsburgh, which the Commission emphasizes as always being necessary, the discharge of settled sewage would probably satisfy the standard.

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*See "Eng. News," Feb. 20, 1912, pp. 398, 412.—Ed.

†The standards under discussion apply to fresh waters. The Commission states that the principle which it has "recommended in regard to special standards for streams [i.e., standards formed to meet special local conditions] might usefully be applied to tidal waters where a standard is considered necessary"; but it still adheres to the conclusions of its fifth report, that "it is not practicable to lay down fixed rules as regards a standard effluent for tidal waters."—Ed.

# A Triple-Plunger Artesian Well Pump

For pumping deep wells 8 in. or more in diameter, where steady flow, large capacity and high efficiency are required, together with absolute reliability of service, a novel form of triple plunger pump has been designed and put on the market by the Deane Steam Pump Co., of Holyoke, Mass.

The essential features of the apparatus are shown in Fig. 1. Three single-acting plungers operate in a cylinder, open at the lower end and with a discharge pipe attached to the closed upper end. The lowest plunger

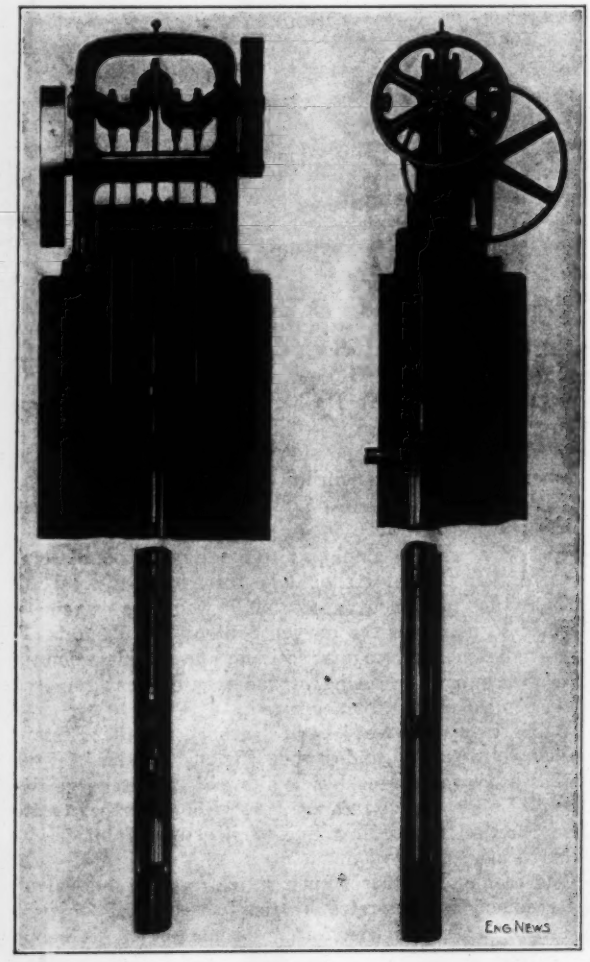


FIG. 1. FRONT AND SIDE ELEVATIONS OF THE TRIPLE PLUNGER ARTESIAN WELL PUMP
(Deane Steam Pump Co., Holyoke, Mass., Makers)

is attached to the end of a solid piston rod, which operates inside a hollow tube that serves as the rod of the middle plunger. This tube in turn operates within a second hollow tube to which is attached the upper plunger. The lowest plunger is driven direct from the crankshaft through a crosshead and the middle and upper plungers are attached to yokes, driven in the same way.

The plungers have valves like a common house pump, which open to allow water to flow upward, but close to prevent the flow of water downward, so that the plungers work only on their up-strokes and the plunger rods are subjected to tensile stresses only. The cranks driving the three plungers are set 120° apart on the crankpin circle so that the plungers act successively on the moving water column to give a continuous and almost uniform flow as shown in Fig. 2. The chart for the pump delivery is nearly as shown in Fig. 3. In other words, the same uniformity of flow is obtainable in this pump as in the ordinary triplex pump. The advantage of this in giving a uniform flow in the well tube of a deep well with a long water column, as well as in the delivery mains, are obvious to every engineer.

This enables the pump to be run at very much higher speed than would be possible with the ordinary single-plunger pump, and thus a large capacity is obtained with a comparatively small pump and a moderate diameter of the well casing.

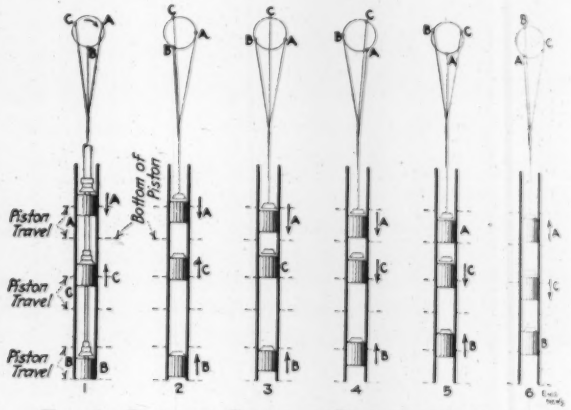


FIG. 2. DIAGRAM SHOWING RELATIVE ACTION OF PISTONS PLACED 120° APART

These pumps are made in sizes from 17 to 135 hp., to handle volumes between 140 and 2250 gal. per min. at

FIG. 3. PRESSURE-TIME CURVE SHOWING THE VARIATION OF PLUNGER DELIVERY FOR A TRIPLE PLUNGER PUMP

depths varying from 35 to 520 ft. The initial installation was made at the plant of a large irrigating company in California, and gave such satisfaction as to induce an order for three more pumps of the same type.

**Eight Large Wireless-telegraph Stations** are to be built for the Marconi Wireless Telegraph Co. of America by the J. G. White Engineering Corporation, according to a recent announcement. Half of these will be sending and half receiving stations; they will be in working pairs, but with sending and receiving units placed 30 miles apart to prevent interference. One pair is to be at Oahu, Hawaii, one at Tamales Bay and Bolinas, Calif., and the third near Belmar, N. J., as noted in Engineering News June 13, 1912. The fourth will be in Eastern Massachusetts, although the site is not definitely announced. It is reported that these stations will permit transmission of messages across the Pacific Ocean, and increase the capacity of the present service between New York and London. The range is designed to be from 4000 to 6000 miles. The towers will be 400 to 450 ft. high, it is reported, there being 12 at each station arranged in a semicircle to support the antennæ.

# EDITORIALS

In the eyes of the law, a corporation is an artificial person, with most of the rights and some of the responsibilities of an individual. This corporate personality has been produced by a process of evolution extending over many years; and the limits to what it may become are still uncertain. f course there are such limits. It would not be practicable, for example, to invite a corporation out to dine and talk over old times. Nor could a corporation be a very active member of an athletic club. On the other hand a corporation may be an active member of some commercial, scientific or technical societies.

There are several organizations in the technical and industrial field whose membership is corporate exclusively. One or two others have both corporate and individual members, but employ different grade names to separate the corporate sheep from the human goats. Other societies, again, make no distinction between corporation and firm, or between firm and individual, but accept any and all of the three in equal standing as members.

The same general principles are now to be extended: inanimate objects are also dignified by the kind of vicarious individuality which hitherto has characterized the corporation. We find that a prominent international association names among its members "The Town Hall, Sydney, N. S. Wales"—truly a personification of wood and stone.

Incidentally, this weighty member has been listed recently under "Changes of Address." We are not informed whether The Town Hall has moved its place of residence from Melbourne to Sydney, or whether, perhaps, Sydney has moved from N. S. Wales to E. W. Wales, or what.

A few things are still left for the future to bring about. We may live to see the time when our friend The Town Hall will be elected a Vice-President of the association, or perhaps its Corresponding Secretary.

## Arbitration between the Railways and the Locomotive Firemen

The decision of the committee of managers representing 54 Eastern railways to accept arbitration under the Erdman Law rather than risk a strike by their locomotive firemen, has received general public commendation. It was generally felt that since the firemen were willing to accept arbitration under the existing national law, even though defective, public opinion would hardly support the railways in standing out for arbitration in a form not expressly sanctioned by law.

The railways are unquestionably right, however, in the warning which they issue to the public that in these matters of railway wages the condition is becoming one which concerns the public even more than it does the railway companies. The firemen themselves, in their published statement, declared that "justice should be granted to the railways by the proper authorities in connection with the proper return on the capital invested, or necessity for increase in freight rates."

It needs only a little study of the records of operating expenses and earnings of the railway companies for the past two or three years to perceive that if the increase in wages granted to engineers and firemen is to be followed, as seems altogether likely, by increases to conductors, trainmen and other classes of organized employees, the public will have to choose between having the railway financial standing so injured that it will not be possible to raise capital for necessary improvements, or there must be a horizontal increase in freight and passenger rates. If rates must be raised, it will probably be freight rates rather than passenger fares, for state laws in many states prevent an increase in passenger fares beyond two cents per mile; and even where such a law does not stand in the way, the reduction in traffic which generally accompanies an increase in rates of fare goes far to offset the additional revenue to be obtained in this way.

We will probably have to be brought face to face with this situation, however, before the public will awaken to the necessity of so amending the Erdman Arbitration Act that the arbitrators may take cognizance of the interests of the public as well as the interests of the parties to the controversy.

## Why American Engineers Should Know the German Language

The paper by Prof. Winslow Herschel, which appears on another page of this issue, is well worth the careful reading of all who are interested in the courses of study in our engineering schools. Prof. Herschel urges that in the present state of engineering science the knowledge of the German language is one of the most valuable acquirements an engineer can possess. Prof. Herschel speaks with a knowledge born of experience, having spent some years in Europe studying foreign practice in various special lines of engineering design.

In our opinion he puts the case none too strongly. It is true that we have in the past in this country to a certain extent made up for the deficiency of the knowledge of foreign languages possessed by American engineers by making use of the constant stream of engineers coming to this country from foreign lands and bringing with them familiarity with foreign languages. It will be recognized, of course, that this is no argument against the teaching of foreign languages in our own schools, but rather the reverse. Boys who are now studying in American engineering schools, if they are ambitious, ought to be desirous of becoming at least as valuable to their employers as their competitors who come to this country from Europe and are able to keep abreast of foreign engineering literature.

Some very eminent authorities have urged that the time spent on modern languages in the engineering schools is largely wasted because so few of the engineering students make use of these languages afterward. They acquire enough of the language to pass the exami-

nations and drop it as soon as they are out of college. This argument, however, detracts nothing from the value of a real working knowledge of a language. The fact may as well be faced that the best time to attain such a knowledge is not in the crowded years of the college course, nor during the high school course, but at a still earlier age. All experts on psychology agree that the proper time to acquire familiarity with a foreign language is during childhood. Of course, a foreign language taught in childhood should be taught by the natural method, and not by the absurd method of teaching the grammar of the language before the language is itself acquired, an educational monstrosity from which so many generations of children have suffered.

It will be evident from the above that in order to thoroughly reform engineering education, one must not deal with the college course alone or even with the college preparatory course, but with the whole subject of education from childhood. We believe, however, that just this very thing must be done if the distinguished committee represents the several engineering societies, which is investigating the subject of engineering education, is to fulfill its highest usefulness. We particularly commend Prof. Herschel's valuable paper to the careful consideration of this committee.

## Where Will City Growth Stop?

Few questions are of deeper interest to the sociologist than the question where the limit will be reached to the growth of great cities. The question is important also to the engineer. All the work of the municipal engineer, for example, is based on the assumption that the growth of cities is to increase in the future as it has in the past. There are, however, certain forces at work, almost unnoticed now, which may work as profound changes as those which were wrought by the progress of invention in the 19th century.

In the last analysis, the reason why people have flocked to the city from the country for the better part of a century is because of economic conditions. Employment all the year round was to be had in the city, and at wages which were, on the whole, better than those prevailing in the agricultural districts. The development of transportation methods and the consequent reduction in cost of carriage has made it possible to carry raw materials from the country to the city to be there put into manufactured form and then carried back to the country and finally sold more cheaply than they could be produced in the country directly from the raw material.

The only means, then, by which the tide of population can be turned from the city back toward the country is some change in economic conditions. There are some signs that such a change is actually occurring. The increasing value of land in the congested districts of great cities has already driven out of the city all industries which require large amounts of land for their operation. The same thing operates to increase the cost of living and consequently the cost of doing business, since the employees of any concern must be paid at least a living wage if the industry is to continue prosperous.

A recent issue of the *Wall Street Journal* contains a significant editorial from which we quote as follows:

> Nothing has had more to do with the high cost of living than the monstrous growth of great cities. Foolish newspapers boast about their city population. What is unquestionably an evil is a matter of rivalry between American cities. Every worker off the soil added to the urban population is an automatic addition to the intolerable burden of the cost of living.
>
> Here is a stupendous fact. London's taxable value has fallen $1,500,000 in the past year, and during the last ten years there has been a net emigration of 550,831 persons.
>
> What will our politicians, mortgaging posterity in all manner of municipal extravagance, say to this plain evidence that cities do not go on growing forever?
>
> There is no great difficulty in explaining a reduction in London's population and taxable value. Transportation is cheaper and better than it ever was before. Municipal experiments, of a benevolently expensive kind, have made the taxpayer's burden so heavy that he is only too glad to move out of the area of extravagance. If this is so in London, what must it be in New York? Our army of tax-eaters is increasing beyond the carrying capacity of taxpayers. The turn in our own population must come in the same way and for the same reason.
>
> Our people do not read history; and our politicians learn nothing from it. The population of Rome, as Mommsen has demonstrated from the water-tax receipts, was not less than 1,400,000 in the time of Hadrian. It is under 400,000 today, and, as a matter of fact, the population was taxed out of the city. Diocletian fixed the prices of some seven hundred commodities, in order to keep down prices, and one-fourth of the city was in receipt of pauper relief. No law could help. The city paid the price of reckless extravagance. Its taxable value dropped to a level where the taxpayer emigrated and abandoned his property.
>
> Here is the cure for extravagance, but it is a desperate one. London is paying the price, and there is no lack of patriotism in saying that she has probably received ten times the value for her money that New York can show, with our greatly heavier per capita cost of administration.

Granted that the above quotation represents an extreme view, it is a view nevertheless that deserves consideration. Statistics recently made public show that the cost of municipal government in New York City averages in the neighborhood of $25 per capita per annum. The enormous amount of borrowed money being spent on great public works in New York well nigh beggars comprehension. Less than a score of years ago, the proposal to spend fifty million dollars in building a rapid-transit subway system was rejected as being too large and expensive, and the project had to be reduced in size before it was accepted. In contrast, the city is now proposing to expend between three hundred and four hundred million dollars on additional rapid-transit subway lines. It has in fact already expended a considerable part of this amount. The cost of the city's new water-supply from the Catskills will probably approximate $200,000,000 before the work is finally completed. The commercial interests of the city are exerting great pressure to have $50,000,000 to $100,000,000 expended in the creation of municipal docks and freight-handling facilities for railways and steamships. Two railway companies are expending each over $100,000,000 in the improvement of freight and passenger terminal facilities in and about New York. The ultra-sanitarians, who take advantage of the popular apprehension regarding the dangers of germs, are at work upon schemes which if carried into effect will compel the city and its various suburban districts to spend hundreds of millions of dollars—it is impossible to say how much—upon long trunk sewers and sewage-disposal plants.

All these overwhelming demands will be eventually translated into taxes, which are laid as a burden upon everyone who owns or rents lands or buildings, and who either lives or does business in the great city. All these burdens eventually represent an economic handicap upon the city manufacturer compared with the manufacturer located in the country. Is it unreasonable to be-

lieve that there must and will come a time when this economic handicap will become great enough to turn the growth of population away from the great centers; if not to the country, at least toward the smaller cities?

## Railway Terminals in Large Cities and the Latest Chicago Terminal Project

The railway-terminal problem in large cities is becoming of increasing importance to railways and municipalities, and to commercial interests as well. In several cities it is a very pressing problem, old terminal facilities being so congested that they are inconvenient and uneconomical. Even though the terminals may have been enlarged, these extensions have frequently been made without regard to a systematic improvement of conditions.

This applies to passenger and freight terminals alike; but while the improvement of the latter is generally by far the most important, agitation for the former is often more insistent due to the demands of the public and to the tendency of the railways to make rather excessive expenditures in this direction under the pressure of such demands.

The railway terminals of Chicago are probably the most extensive and complex in this country if not in the world. Numerous main-line railways (some 25 in number) approach the city from different directions, and their tracks cross each other at various points, making a very unsymmetrical arrangement. This is due, of course, to the fact that the lines were built at various times, each with regard to its own requirements and without any regard to a harmonious relation of the lines. This has resulted in making much land unavailable for development, and in interfering with traffic and with a proper development of the railway approaches to the city. It has resulted also in enormously expensive works for the elimination of highway grade crossings at some points and for elimination of railway grade crossings at other points. Further than this, it has resulted in a chaotic arrangement of freight yards and facilities in and around the city, each built with regard mainly to the needs and convenience of the owning line, or perhaps where it was at the moment able to obtain land, and without regard to its relations with other railways or with the needs of the city's freight traffic.

These conditions were discussed in our issue of May 9, 1912, and as far as the approach lines are concerned, the conditions seem beyond the possibility of any radical alteration. There is, however, a possibility of improvement by the concentration of interchange freight yards and the more extensive handling of interchange cars (or through cars) by belt lines, so as to keep this class of traffic outside of the city and out of the local freight yards. Such improvements have been proposed many times, and certain changes have been decided upon, but only slow progress is being made toward carrying them into effect.

Within the city, and especially within its congested business districts, the conditions are even worse. Large areas of valuable land are occupied as freight yards, coach yards, etc., and as the areas owned by different roads are contiguous, they form a great extent of waste land, the occupancy of which for such purposes prevents its own development, reduces the value of adjacent property, and obstructs the proper growth of the city. There is a very real need for improvement in this direction, but it cannot be effected on the broad basis that is necessary without coöperation on the part of the railways; and there is very little indication of any general improvement of the city freight-terminal system as a whole.

Referring to the passenger-terminal situation in Chicago, there are six widely separated passenger stations; and there are no lines of systematic or convenient communication between them (such as street-car lines or elevated railways), which is one of the weak points in the local transportation system. Numerous projects have been proposed for a centralization of passenger-station facilities, but under present conditions (noted more fully later) the advantage of this appears to be rather doubtful.

One of the first of these projects was that of Gen. Torrance (1892) for a union station to occupy land fronting on State and 12th Sts., which was then (and still is) occupied by freight tracks. Other projects were those of R. C. Sattley (1901) for a station at Harrison to 12th Sts. on the west side of the Chicago River, and of F. A. Delano (1905) for a series of individual stations fronting on 12th St., near the river.

The latest project is one advanced by Jarvis Hunt, a Chicago architect (who is architect of the new Kansas City union station), and which includes a centralization of passenger and freight facilities in one immense terminal fronting on State St., between 12th and 16th Sts., and extending west to a new and straightened channel of the Chicago River near Canal St. As in other projects, the site would occupy land already owned by the railways, and its utilization in this way would enable large areas of undeveloped land, now occupied by freight tracks and freight houses, to be released for more remunerative use. The plan has some good features (as had the others), but it is not a difficult matter to prepare a good project on paper. It is open to the objection of being so large as to be unwieldy in management and operation.

It may be questioned also whether it would be beneficial to combine all freight and passenger facilities in one immense terminal. The important questions to be considered in regard to a project of this kind are: First, the benefits to the city, the commercial interests, the railways and the public; second, the support which will be given by the railway companies (which, it is taken for granted, will have to foot the bills), and what assistance might be rendered by the city.

The fundamental question, however, is whether the railways will accept and support the project, and this feature of lack of railway support has been the main reason why none of the previous projects have been carried out. As to the passenger station, there are apparently no great advantages to be obtained. And as to the freight facilities, the present unfavorable conditions above outlined have been stated again and again, and it has been shown clearly that they are unfavorable to the railways, the commercial interests and the city, but the showing has been without practical effect. It would seem to be a rather hopeless task to endeavor to secure the definite approval and active support of any such project by the score of railway companies concerned.

Probably this condition influenced Mr. Delano (President of the Wabash R.R.) in his project for a series of

adjacent terminal stations, which could be built by the different roads as conditions might require. This would have required harmonious or concerted action in the location of sites, but would not have required consolidation of interests or of investments.

In addition to this difficulty of securing coöperation, Mr. Hunt's proposed plan would necessitate diversion of the Chicago River, and this is a matter for which consent of Congress and the War Department would have to be obtained.

The necessity of securing the support of the railways in the first place has been shown very forcibly in the case of the extensive car-interchange yards built at Chicago by an independent company nearly twelve years ago. The purpose was to relieve the city freight yards by doing all transfer or interchange of through cars at a yard outside the city. The yard was built and equipped in a very complete manner, and included electric operation of the switches by which cars were diverted from the gravity track to the several classification tracks, all these movements being controlled from a tower or bridge spanning the summit of the hump or gravity track. Such a plant was useless unless the coöperation of a number of railways in its use could be effected, and as this coöperation could not be secured, the yard has remained unused ever since it was built, except that some of its tracks were leased for storage. Last year, this yard was acquired by one of the freight belt lines, and may eventually be put into use.

In regard to Mr. Hunt's proposal for one central union passenger station at Chicago, the great union passenger stations at New York and Kansas City have been cited as indications of what is desirable and may be expected at Chicago. But the conditions at the two former places are entirely different from those at the last named place. Each of the two new terminal stations at New York is in the control of a single railway company. At Kansas City, there has long been one union station used by practically all of the railways entering that city, and the problem was the reconstruction of the station and terminal facilities on modern lines. But several years were consumed in harmonizing the various railway and other interests.

At Chicago, there are six large passenger stations which serve some 25 railways; one is used by one railway only, and the others are used by three to six railways each. Two of these stations are of modern construction (one of them opened as recently as 1911), plans have been adopted for the reconstruction of a third on a vast scale, land has been acquired for the reconstruction of a fourth, and the reconstruction of a fifth within a few years is probable. It has been suggested that the aggregate expenditures on these separate stations would exceed that required for a single central union station, but no figures have been given on which to base such an opinion. At any rate, the railways seem to take no interest in union-station projects, and with many million dollars invested in individual stations, the railway companies have little incentive to enter into a scheme for a costly single central station (administered by a terminal company), which would mean the practical abandonment of existing stations, except perhaps for some suburban and local service.

There would be no particular benefit to the railways or the public from the consolidation, and there would be some distinct disadvantages. There would be a little less inconvenience for through passengers transferring from one road to another, but Chicago is distinctly a terminal city. Not a single railway passes through it, but all terminate in it; and the number of through passengers who do not make any stay in the city is very small. Most of those who have to transfer from one station to another use cabs or railway transfer buses, and the convenience of others could be provided for simply and economically by arranging belt routes of street cars to connect all the stations.

A condition directly unfavorable to a project for such a single terminal station is that the construction of huge and costly passenger stations has been overdone. There is, it is true, a continual public demand for fine stations; but we have pointed out before that where the demand is largely on the basis of desiring a handsome building as an ornament to the city, the cost (above that for a reasonably commodious and handsome structure) should be borne by the city and not by the railway. In the latest great stations there has been a tendency to expend enormous sums on elaborate design and decoration, and luxurious fittings and accessories. Costly finish and fittings in a hotel or an office building may be a good investment, bringing returns by attracting patrons or tenants of a class able and willing to pay high rates or rents. But a railway cannot increase its rates on account of its investment in stations, and no passenger is influenced to travel on a particular railway because its station is beautifully finished in marble and bronze.

This is not saying that a station should not be of handsome design and finish. It does mean that there is no necessity for the excessively elaborate and enormously costly work which has become a feature of recent American terminal stations. Convenience, comfort and good train service or facilities are the important points to be considered by the railway in its relation to the traveling public. In this direction, our railways could benefit by a study of foreign practice, which might have a restricting influence upon the tendency to lavish and unnecessary display. Under present conditions of railway finance, the companies might well regulate their expenditures more closely as to the non-essentials and more liberally as to the essentials of railway service. We discussed this question at some length in our issue of Oct. 28, 1909, and pointed out at that time that these elaborate stations are really luxuries, since they yield no return on the investment and require a perpetual annual outlay for care, maintenance and taxes.

**Almost every other outlay which a railway makes in improving its property is made with a view of receiving a return on the money invested in the shape of reduced cost of moving traffic or increased volume of traffic. But expenditures on passenger stations, in excess of moderate and reasonable requirements, is an investment which is a burden instead of a benefit to the property.**

Incidentally, attention may be called to the common failure to utilize the areas of passenger terminals to produce revenue. In most cases, the station provides nothing but station accommodation. An exception to this is the La Salle Station at Chicago, which has an office building erected over the headhouse or station proper. On the other hand, the new Chicago & Northwestern Ry. station in that city, costing several million dollars, is a station and nothing more. Yet the railway company occupies an entire office building not many blocks distant, and could have accommodated all its departments in a building over the station, releasing the present office building.

But apart from questions of expense of land or buildings, it is entirely probable that there is a limit beyond which concentration of freight or passenger traffic in a terminal becomes unprofitable. Overcentralization is a condition and not a theory in some of our great industrial organizations. There are already, we believe, numerous railway freight yards so large that they have outgrown the capacity of the organization in charge to control the movement of cars through them and prevent delays.

To concentrate the enormous railway freight or passenger traffic of Chicago in a single great terminal would seem, on its face, a proposition far too large to admit of economical operation.

# LETTERS TO THE EDITOR

## Tests vs. Theory in Reinforced-Concrete Flat Slabs

Sir—An editorial article in ENGINEERING NEWS, Jan. 16, 1913, criticizes a paper given at the recent convention of the National Association of Cement Users, on the test of a reinforced-concrete flat-slab floor. The point in the criticism is that the failure of the author of the paper to give a detailed description of the amount of the steel reinforcing in the floor tested renders the paper so useless to the public that the editor does not think reprinting worth while. The editor, of course, concedes to the company making the test the right to withhold any part of the data, but questions the loftiness of its conception "of its duty toward the profession." So, of course, the writer concedes to the editor the right to reprint the paper or not, but questions the correctness of his verdict that the paper as given was worthless.

In the test referred to, measurements were taken which showed with the greatest accuracy obtained in any test yet made public the actual stress curves for both steel and concrete on five lines radiating from an interior column. Five points on the line of inflection around the column are thus located. The paper gives most of this information and the thickness of the slab, together with a summary of the stresses in steel and in concrete measured at more than 250 points in the floor panels loaded.

In a forthcoming bulletin of the University of Illinois Engineering Experiment station, "Tests of Reinforced-Concrete Buildings Under Load," of which the writer is joint author, the data given show that in general the concrete stresses rather than the steel stresses were critical. This has been shown in other tests also in which the writer has taken part. In some tests, the steel stresses have been very small as compared with the concrete stresses, but in no tests of which the writer knows can it be said that the principal concrete stresses were shown to be small in comparison with the steel stresses. With a given load on a floor of a given thickness the stress in the concrete will be nearly independent of the amount of steel used. With these facts in view, a knowledge of the stresses developed in the concrete with this load and this thickness of slab ought to be "worth while" to a designing engineer, though, of course, it would be still more valuable if he could know how much steel was used. The paper criticized would put at the disposal of the profession not only some details of design, but also information on the mechanics of the action of the flat-slab floor, which is of more general interest than knowing how much steel was used in the particular floor tested.

W. A. SLATER,
Engineering Experiment Station,
University of Illinois.

Urbana, Ill., Jan. 31, 1913.

[The test which we criticized was made on one floor with a fixed type of reinforcement. Obviously there could be no deduction from it that the stress in the concrete is not materially affected by the amount of steel, nor do we consider that assumption a fact of such common knowledge that the author of the paper could take for granted that the amount and distribution of the steel were immaterial to a determination of both stress and inflection points.—ED.]

## Tests and Performance of Flat Slabs

Sir—Your editorial re "Flat Slab Floor Designs," Jan. 16, 1913, p. 123, was very apropos, and it placed no unnecessary emphasis upon the existing lack of knowledge as to actual stresses in this type of concrete construction.

We know the general superficial results from test loading such floors, but these very results leave us in doubt as to just what they portend, for seemingly slight and unimportant defects of today may mean practical failures after ten years of continuous service. With rare exceptions, there are few of these structures over five years old, and some of them are showing increasing defects as they age. The writer has designed some steel supports for special sections of floor in one such building which had been in service only two years.

We suppose that the circumferential cracks around the column heads, in the floor surface, indicate an excessive stress in the steel and concrete; and then, in the same type of design, the center portions of the panels develop "crows feet" cracks when there is much trucking over them with the consequent vibrations, and the surface finish breaks up and deteriorates rapidly adjacent to the cracks. Does anybody know how long such defective sections will continue safe for the "designed" traffic? In the latter instance, as there is no steel at all in the top of the slab to take care of the tensile stresses which must develop under the vibration, the result is readily understood.

Then again, in one building examined by the writer, temperature or load stresses have caused cracks, which allowed water to leak through, to develop in a 15-in. thick slab; these cracks occur approximately along the outer

edge of, and parallel to, the "belt" of reinforcement on the longer spans between columns, the longer span in this instance exceeding the shorter by almost 40%.

There was another interesting feature which developed in the completion of a building of flat-slab design and which the writer investigated. In this instance the typical slab was 9 in. thick and the column heads were depressed about 3 in. for an area 7 ft. square, the column centers being about 23 ft. in one direction and 21 ft. in the other. The finish floor-coats were being placed about one month after the slabs were completed, and these had been poured in warm weather and were set up good and hard. It was noted that the bonding, which was otherwise exceptionally good, would break and sometimes buckle up slightly on almost a straight line between columns. This break usually reached all the way up to the columns, but was more extensive in the half span space between columns; and while it developed in every instance on the 23-ft. span lines, it was far less extensive along the 21-ft. span lines.

This was at first attributed to various causes, but as new and additional precautions were taken as the successive floors were started and the results continued the same, it became necessary to find the real trouble. The damaged lines were taken up and relaid without any improvement in results. It was finally noted that whenever a wheelbarrow was being wheeled over the floor that there was a very perceptible vibration, and then as a result of careful observations and considerations the conclusion was finally reached that what might be termed the upward waves of vibration were responsible for all the trouble. It should be noted that there was no top steel in the slab to resist this motion and the bottom "belt" of steel ran at right angles to the line of upheaval. The columns were, of course, the only fixed points of support, and any lines of movement should naturally radiate between them. That the maximum lines of upheaval occurred on the square lines between the columns rather than the diagonal might seem peculiar, but as there was more dead weight, and the consequent deflection, to overcome upon the diagonal line, the results as actually noted were probably most logical. Has anybody reinforced against this action, or is it possible that it has never happened elsewhere?

Then again, there are instances of buildings, side by side practically, having flat-slab floors "guaranteed" by their "designers" to have safe load capacities, which happen to be exactly identical and which do not differ more than 5% in the amount of concrete involved per square foot of floor, but one will be reinforced with over 50% more steel than the other! This must indicate ignorance or knavery.

A. C. AREND.

Brandeis Bldg., Omaha, Neb., Jan. 25, 1913.

## Investigation of Concrete Pavement in Chicago

Sir—In your issue of Sept. 26, 1912, p. 558, there appears an article by P. E. Green on "Concrete Pavements; Their Advantages and Disadvantages." This article has been reprinted in leaflet form and is being given wide circulation by certain paving interests in an effort to prejudice property owners and others against concrete pavement. Such an article would have neither weight nor influence if it were not seemingly vouched for by ENGINEERING NEWS, which fact is being exploited on the leaflet.

The writer believes that you should be made acquainted with the facts regarding the single example of concrete pavement cited by Mr. Green in this article, that you might have the opportunity to protect the best interest of your publication and give these facts as wide publicity as you gave the original article.

Possibly Mr. Green was sincere in the views expressed in his article, but the use which has been made of it causes one to question whether or not he was entirely unprejudiced in this matter.

Mr. Green bases all his arguments and conclusions either on theory, or upon the observation principally of a single concrete pavement which no one would claim is representative. An impartial consideration of all the relevant facts regarding the construction of this particular pavement shows that Mr. Green's conclusions are wholly unwarranted.

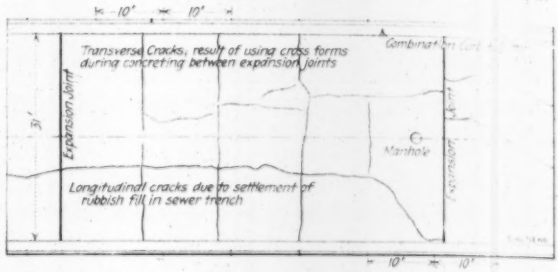


FIG. 1. PLAN OF PORTION OF OHIO ST., CHICAGO, SHOWING CRACKS IN CONCRETE PAVEMENT.
(Submitted by Mr. Powell.)

Admittedly, the concrete pavement on East Ohio St., Chicago, is defective, and it is not the writer's intention to attempt to minimize these defects, but if any value is to be derived from directing attention to examples of unsatisfactory construction work, there also must be presented an analysis outlining truly and intelligently the real cause of its condition, so as to provide information whereby the same mistakes can be avoided in the future. Mr. Green has neglected to consider conditions directly responsible for the present unsatisfactory state of the Ohio St. concrete pavement, and this makes the whole article misleading.

The present condition of this pavement is not due to any "grave defects" or "characteristics" of concrete which make it an unsuitable material for a pavement, as the article referred to makes it appear. Had the pavement been laid on anything like a solid foundation, and according to present good practice, the cracks, which are the only objectionable feature of this pavement, would have been avoided.

Ohio St. from St. Clair east, a distance of 2200 ft., is a fill composed of manure, bed springs, wood, tin cans and all sorts of material which go to make up a city's rubbish dump. It is improbable that a fill composed of such material as that mentioned would ever become sufficiently compact so that it would be advisable to place over it a concrete pavement without reinforcement. Just prior to the laying of the pavement, 1800 ft. of this street was torn up in the center to a depth of 10 ft., for the construction of a sewer. Sheeting was not used the full depth of the trench, and as a consequence, the trench

was about 16 ft. wide at the surface. The excavated material alone was used for backfilling. On this account the paving contractor states he laid the pavement under protest and that he tried to compact this back fill at an expense to himself of several hundred dollars.

Under these conditions, settlement was bound to occur and at places the amount has been considerable, as is shown at one or two expansion joints by a difference in elevation of 0.08 ft. between the adjoining sections. There are large areas of this pavement which sound hollow under a passing steel-tired vehicle. From this it is obvious that settlement is the direct cause of the longitudinal cracks, yet the engineer "who witnessed this construction," would have us believe these cracks are due to the "susceptibility of concrete to temperature changes."

The transverse cracks shown in the accompanying cut (Fig. 1) occur at regular intervals of 10 to 15 ft., the entire length of the pavement. These cracks are not caused by placing the expansion joints too far apart, because in some places the distance between expansion joints is only 25 ft., but they mark the location of the forms or bulkheads placed across the street during concreting to provide a means of striking off the surface to conform to the crown of the pavement. After serving this purpose, these strips were removed and the space filled with concrete which made a joint across the pavement. The bond at this joint could not be expected to develop sufficient strength to withstand the stresses set up in the pavement by contraction and settlement, and therefore the transverse cracks developed along these lines of weakness. The present approved method of constructing such a pavement is to lay each section continuously between expansion joints without cross-forms, and this is the only satisfactory method to follow.

The only way in which a concrete pavement could have been laid on Ohio St. with successful results would have been to provide an adequate foundation and then, on account of the height of the fill and the width of the street, to have reinforced the pavements its entire width with steel-wire fabric and provided expansion joints every 25 ft. Although no "rapid abrasive action" has become evident at the expansion joints in this particular pavement, it is now considered the best practice to protect such joints by metal plates.

Mr. Green cites Ohio St. as an example of concrete pavements under a "moderate traffic (for example 150 vehicles for 24 hours)." A recent traffic census on this pavement, taken over a period of one week, showed an average of 526 vehicles per 12½-hour day. Of this number, 324 were teams, 31 motor trucks and 171 passenger automobiles. After four years under such heavy traffic, the wear on this pavement, aside from that occurring at some of the longitudinal cracks, is not excessive and the corrugations are responsible for most of that which has occurred. It is an accepted fact that a plain concrete pavement is not slippery, but if corrugations are used, it is self-evident that the wear on such a surface would naturally be more rapid while the corrugations were wearing off than afterward. The condition of this pavement does not justify Mr. Green's statements that concrete is not suitable for streets carrying traffic in excess of 200 vehicles per day.

The surface-wearing qualities of various kinds of pavements were tested recently by the city of Detroit, Mich., by a machine designed for the purpose. It consists of two large weighted metal wheels, one on each end of a horizontal shaft which revolves around a central vertical pivot. The shaft is slowly moved back and forth so that the wear from the wheels is distributed over a circular area 2 ft. wide, paved with the different materials to be tested. The shaft is also hinged so that the wheels will follow any inequalities worn in the surface of the pavement. Each wheel is equipped with five plungers faced with steel horseshoe caulks, mounted on a device which causes the caulks on each plate to strike the surface of the pavement a severe blow as the wheels revolve. The weighted wheels correspond to the tires of the vehicle and the caulks to the tread of the horses, thus producing practically the effect of street traffic.

In this test the machine was run at a speed of five miles per hour over various "permanent" pavements and the material which stood up the best under this punishment was the section of concrete laid under the specifications of the Wayne County Road Commission. The wear on the concrete was hardly perceptible.

To the writer the article in question shows a limited observation of concrete pavements and an unfamiliarity with present practice in their construction, otherwise such erroneous conclusions as the author formed would be impossible. During the last three years the writer has been closely identified with the investigation of over two million square yards of concrete pavement in various parts of the country and in no instance when proper materials and methods of construction were used, has the concrete failed to be entirely satisfactory.

C. M. Powell,
Assistant Engineer,
Universal Portland Cement Co.

Chicago, Ill., Jan. 10, 1913.

[It should be unnecessary to remark that Engineering News did not "vouch for" Mr. Green's facts or deductions any more than it does for Mr. Powell's. The reprints noted above were made by our job printing department as a matter of routine business.

Mr. Powell's letter was submitted to Mr. Green and has brought forth the following reply.—Ed.]

Sir—The various points made by Mr. Powell will be discussed briefly. At the start it should be stated that the writer is not opposed to concrete pavements in their proper place. He maintains, however, that city streets, with roadways over 18 ft. wide and carrying any considerable city traffic, are not the proper place for them.

The statement that the article in question has been reprinted and incorporated in leaflet form was news to the writer. Some months ago a request for the permission to republish was received and the writer referred the inquirer to Engineering News, with the statement that he had no further interest in the matter, having disposed of the article in question to that journal.

The personal criticisms of the writer's experience and motives may be passed over with the statement that the writer has personally supervised the construction of some $6,000,000 worth of street pavements in his professional career and therefore is of the opinion that he is entirely competent to judge of such matters.

Mr. Powell has taken the photograph showing an example mentioned in the article and made a very eloquent explanation of why the pavement failed. In his explanation he has made many misstatements which may be taken up in detail.

The statement that the ground was an unsuitable fill is incorrect. The pavement was laid on a first-class, solid foundation of sand, there being practically no rubbish on this site. This statement is made not only from the personal knowledge of the writer, but such observation has been confirmed by the engineer in charge of sewer construction for the city of Chicago, who states that the excavation for the sewer was practically all clear and very wet sand. This street is located in what is called Streatorville, named after Captain Streator, and is largely made land formed from washings of sand from Lake Michigan. The district as a whole was used as a dumping ground for many years, but as stated before, on this particular street there was very little rubbish. The sewer department of the city of Chicago also states that particular care was taken to backfill thoroughly the sewer trench.

In the same year that the pavement was laid a 2-ft. sewer was constructed in Ohio St. from Fairbanks Court to Lake Shore Drive, a distance of 1565 ft., not 1800 as stated in Mr. Powell's letter. The part shown in the published photograph accompanying the writer's original article, was west of this sewer construction some 500 ft., and therefore not at all affected by the construction of the sewer. In fact the west 600 ft., which sustains probably the heaviest traffic on the street, is in the worst condition by far. The east 1600 ft. is badly cracked in every direction, but this, however, is certainly not the fault of the sewer construction. There is absolutely no sign of settlement either on the streets or on the adjoining curb. Such unevenness as does occur (which is noted as being 0.08 ft. between adjoining sections) is undoubtdition has arisen, not because of settlement of a sewer pavement above the sub-grade. This phenomenon is evident not only on the section in which the sewer was laid, but on sections in which none was constructed or edly entirely due to expansion and contraction. There are indeed large sections of this pavement which sound hollow under a passing steel-tired vehicle, but this conwhere the sewer construction could have no effect.

The writer does not believe the many transverse and longitudinal cracks shown in Fig. 1 are the result of the trench, but because expansion has bowed or raised the use of the forms placed across the pavement during concreting. They are entirely too irregular and have too much of a wandering character to be accounted for in such a manner. The explanation is not plausible and inadequately accounts for the pavement's condition.

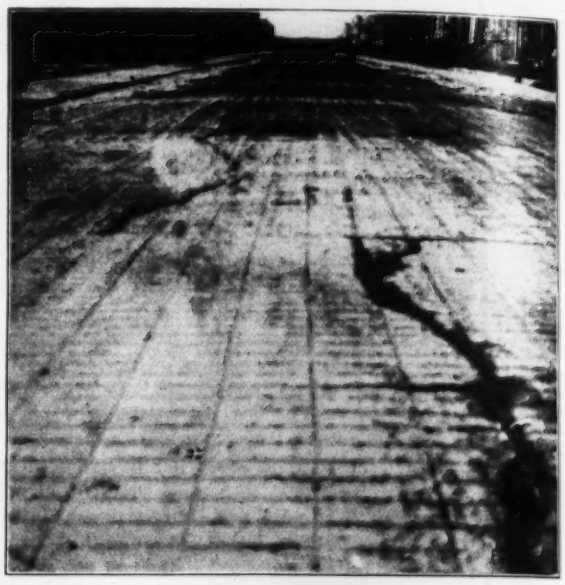

FIG. 2. 21ST PLACE, WEST FROM 41ST AVE.

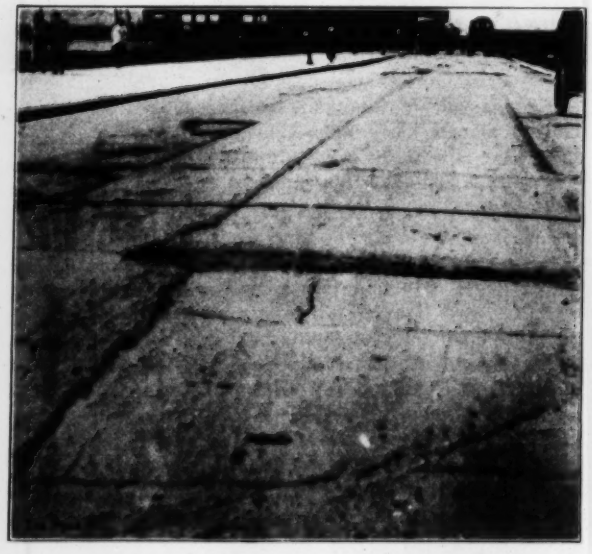

FIG. 3. HARVARD ST., WEST OF KEDZIE AVE.

FIG. 4. HARVARD ST., WEST OF KEDZIE AVE.

FIGS. 2-4. VARIOUS CONCRETE PAVEMENTS IN CHICAGO
(Submitted by Mr. Green.)

No statement was made in the article as to the amount of traffic on Ohio St., though Mr. Powell in his letter intimates that the writer stated that there were 150 vehicles in 24 hr. and quotes a recent census to the effect that there were 324 teams over this street in a 12½-hr. day, exclusive of automobiles. Automobiles may be

eliminated from the question, as their rubber tires have little or no effect on a concrete pavement. This was so stated in the writer's article.

In regard to the amount of traffic, the writer is frankly surprised and somewhat skeptical, but he has no means of disproving it at this time. Ohio St. is largely lined by vacant property. At the extreme east and west ends, and at intervals, there are some large business houses. But though the writer has been over the street many times, he never saw evidences of this much traffic. However, in any case, 324 vehicles is but a light traffic on a business street. As a comparison, Lincoln Ave., in Chicago, which is known as a secondary business street of the North Side, has, in the vicinity of Belmont Ave., an average traffic in 12 hr. of about 1800 vehicles, exclusive of street cars, while in streets of heavy traffic, such as Clark St., in the Loop District, the vehicular traffic runs as high as 10,000 in 12 hr.

The writer has examined practically all the concrete pavements in Chicago exclusive of alleys, and these examinations have been made at irregular intervals covering the past five years. Practically all of them, whether the traffic is light or heavy, are in bad condition after they have had three years of use, and this condition is due, first, to cracking and, second, to abrasive action, which is apparent after the cracks develop. As an example may be cited what is called the Stock Yard pavement included in the Union Stock Yards in Chicago, which is in horrible condition. This was laid by private contract in 1908. The same is true of a concrete loading areaway and driveway in front of the Western Packing & Provision Co.'s warehouse in the same district. Twenty-second St., from 41st Ave. to 42d Ave., a street of moderate traffic, is in frightful condition. Twenty-first Place, west from 41st Ave., and practically a dead-end street, is also in bad condition and getting worse. The traffic is exceedingly light. Fig. 2 shows this. Figs. 3-4 show the condition of concrete pavements in front of the Sears, Roebuck & Co. plant on Harvard St., west of Kedzie Ave. These streets are in exceedingly bad condition and are being constantly repaired. The traffic is heavy. The corrugations have been worn almost smooth and the repairs now occupy more space than the original pavement and in some places repairs have been made several times.

In some of the above streets sewers were laid but a short time before the pavement was constructed, and in some the sewer was laid several years prior to the pavement construction. There is little to choose at this time between them. On 21st St., from 41st Ave. to 42d Ave., a street of very light traffic, the sewer was laid the previous year. This pavement in places shows signs of settlement, but is the only one that does. However, the street itself is badly cracked far outside the lines of settlement. Ontario St., from St. Clair to Lake Shore Drive, the next street north of Ohio, was paved with concrete in 1909 and 1910, and in part of the street a sewer was laid in 1908. The street is badly cracked. The traffic is light. Emerald Ave., between 73d and 75th, paved with concrete in 1908; Union Ave., from 73d to 75th, paved with concrete in 1909; Lowe Ave., from 73d to 75th, paved in 1911, are all very badly cracked. Schulze Ave., from 113th to 115th, paved with concrete in 1905, is in horrible condition. The traffic is heavy.

On Randolph St., on the west approach to the bridge over the South Branch of the Chicago River, a section of concrete pavement was laid in 1904 in front of Butler Brothers' warehouse. It replaced granite block and it has been stated that it was guaranteed for five years. In 1909, at the end of the guaranty period, what remained of it was taken up and granite block substituted for it. The traffic is very heavy, this stretch being but a short distance from the Loop District. During its service it was constantly being worn into large holes and as constantly repaired.

In the letter, comment is made on the new testing machine advocated by the city of Detroit. The writer saw this machine in the recent Cement Show in Chicago. He saw very carefully laid concrete slabs compared to very carelessly laid creosoted-wood block and brick pavements to the confusion of the latter. The test was absolutely childish. Any machine which by test produces results that are contrary to hard experience, simply brings ridicule on scientific observation and theory. The absurdity of a concrete pavement outwearing a first-class granite-block pavement needs no comment. The writer would suggest that blocks of concrete in the form and size of granite blocks be subjected to a rattler test and the result published.

Frequent mention is made of the results obtained by the Wayne County Road Commission of Wayne County, Michigan. The results obtained in this county on country roads are excellent. The oldest road is only four years old and according to the statement of one of the County Commissioners, is badly cracked. However, this commissioner states that this cracking has been largely overcome. The writer is inclined to think that his statement is correct. These roads have an average width of about 16 ft., and expansion joints placed every 25 ft., and they are *country* roads. It will be noted that the writer in his article stated that he believed on a country road, where the value of the abutting property would not be affected by cracking and where the traffic, even when called heavy for a country road, is light in comparison with a heavy city traffic, concrete might be entirely suitable.

One of the strong points made by the writer in his article was that any pavement which by reason of its character developed unsightly cracks in every direction was a positive detriment to the abutting property, as it would undoubtedly reduce its value.

The writer has examined concrete pavements in many cities and invariably has found that when the pavements are two or three years old, they are badly cracked. Examples of this cracking may be found in Gary, Ind., and Mason City, Iowa, both of which cities have in their time been advertised widely as to their beautiful concrete pavements. Very little is heard of these pavements now. In conclusion the writer might state that at a special meeting for the discussion of concrete pavements in the rooms of the Western Society of Engineers, one of the County Commissioners of Wayne County, Mich., who addressed the meeting, advised municipalities to go slow in putting in concrete pavements on city streets, as their development had not yet demonstrated that they would be satisfactory under such condition.

A very able paper on concrete expansion and contraction was presented by Logan Waller Page, Director of the U. S. Office of Public Roads, before the Ohio Engineering Society in 1912, and published in its proceed-

ings. It would be well for all interested in the subject to read this article.

P. E. GREEN.

17 N. La Salle St., Chicago, Feb. 4, 1913.

## Concerning the Efficiency Society

Sir—I have just had called to my attention your editorial on the Efficiency Society in your issue of Feb. 6, and have been interested in what you conceive to be the field of the Efficiency Engineer.

For instance, you state that you see no necessity for the establishment of a new society of this kind so far as efficiency in relation to engineering work is concerned, and give as your reason that a special section of the American Society of Mechanical Engineers has been organized to devote itself to the so called Science of Management, and that this seems to fill all the necessary requirements for the mechanical engineers at least.

Let me state, in the first place, that there is no special section of the American Society of Mechanical Engineers such as that which you designate, but that before the Efficiency Society was started an effort on the part of certain of the members of the American Society of Mechanical Engineers was directed toward the starting of such a Section, and it aborted because it was decided by the Council of that Society that such service as efficiency engineers supply was not mechanical engineering.

There is, however, a Committee of the American Society of Mechanical Engineers which devotes itself to the subject of administration, and confines itself to a consideration of the subjects involved in machine-shop management, all of which is very proper for a Society of Mechanical Engineers; but the subjects of business promotion, of business finance, of organizing the forces involved in a business enterprise, of credits, of the collection and disbursal of funds, of advertising, or selling, of purchasing, of the principles of management, of cost accounting, of so called welfare work, of employment, of the medical supervision of the employee, of profit sharing, of systems of wage payment, of pensions of beneficial organizations, of accident insurance—these are not mechanical engineering, but are common subjects of interest to people in all lines of business.

In this city alone there are some 700 factories in which engineers may profitably be managers, but the 27,000 involving the cloak makers, the white goods manufacturers, and the hundreds of other industries which do not know an engineer in their organization—these involve the factories in which the members of the Efficiency Society are interested.

You quote at some length one paper on "Scientific Selection and Assignment of Men in the Creation of an Organization," and say that it seems well nigh unbelievable that it should find a place in the proceedings of a so called "scientific society" of the present day.

I do not know who calls the Efficiency Society a scientific society. I am sure it has never claimed to be such, but I can state that the author of the paper referred to is in charge of the selection of the employees of one of the largest manufacturing concerns in this country, now being reorganized by an efficiency engineer who is a member of both the American Society of Mechanical Engineers and the Efficiency Society, and has been selecting employees under the system outlined in that paper at the rate of over three hundred per month for a considerable period of time, and after the paper was widely quoted in the press throughout the country and was distributed to the membership of the Efficiency Society, orders have been coming in for copies in lots of 500 and 1000 for distribution among the employing heads of the largest concerns in the country.

The author of your editorial, however, stamps the standard of your paper in not quoting the papers on Organization and Management which were read by members of the American Society of Mechanical Engineers, of which he claims to be an exponent, but selects this one paper for full exploitation in your issue, because, as he says, it was heralded in large headlines by the daily papers, which notoriously are given to selecting the most sensational features of an occasion in order to satisfy their readers.

H. F. J. PORTER,
Secretary, Efficiency Society.

29 West 39th St., New York City,
Feb. 14, 1913.

## The Status of the Engineer

Sir—I have read your recent comments on the "Status of the Engineer" and agree with Mr. Hazlehurst, who states in his letter, in your issue of Jan. 23, that the trouble with engineers as a body is (1) lack of homogeneity and team work, (2) little regard for ethics, and (3) a very decided tendency toward commercialism in service. May I state as a fourth trouble, the posing of so many men as engineers who are absolutely unworthy of bearing the name and unfitted to carry the responsibilities that fall on one practicing as an engineer.

The general public regard the engineer only as an occasional necessity and often seem to prefer their own ideas and judgment even on technical matters, rather than those of a man trained to handle such matters. Too little importance is placed on the engineer in the settlement of important public questions.

In my opinion the remedy is this: The engineers as a body must come together, demand recognition, and require that only those be allowed to practice the profession who are able to pass a state examination. Let this examination be agreed upon by a board of competent engineers of reputation. The old objection arises in some minds that many good men might be weeded out. This, I think, would not happen, for any able engineer, though possibly not able to answer all the theoretical questions as completely correct as a recent graduate, still would be able to show any reasonable board of examiners in his own way that he knew his work. Should there be a feeling that there would be chance of too many raw graduates passing this examination while seasoned men failed, let the examination be so arranged as to make it necessary for a man to have had field as well as college or other training to secure the right to practice.

These requirements would be no more than are required in the other "professions." The word engineer has become so general that the opportunity to practice seems to depend on how much a man could induce another to believe that he knew, rather than what he really knew. Opportunity to practice depends so much on influence that the time is not far distant when the profession of engineering will cease to be recognized as a profession

and become merely, as Mr. Whinery has said, "one of the valuable commercial assets of business organization."

Then, before it becomes too late and before our profession becomes anomalous, let us demand that every man who practices the profession of engineering be required to furnish proof of his ability to do so, and of his right to good standing in his profession.

D. S. PERRY.

Leesburg, Fla., Jan. 27, 1913.

## The Present Status of the Engineer

SIR—The recent articles in ENGINEERING NEWS upon the status of the profession make very interesting reading, and those who have devoted their time and study to the questions involved are rendering a distinct service to engineers everywhere.

This matter has been gradually fermenting. For years there have been read, at the various engineering society meetings, thoughtful papers on such subjects as "Compensation for Engineers," "A Recommended Scale of Prices for Engineering Services," "Why are Engineers So Poorly Compensated." Many questions of professional ethics have been discussed and various committees have been appointed to frame codes. Attempts have been made to secure legislation restricting the practice of engineering to those who have been found qualified by some board, but in only a very few instances have such attempts been rewarded with any great measure of success. All these efforts are praiseworthy, but it is difficult to see how they have improved the status of any considerable body of engineers, either as to their compensation, the dignity of their calling, or their professional, business or social relations. Committees may fix scales of prices for engineering services, but only those who are in private professional practice are interested in them. Moreover, rates which are reasonable for certain services in Chicago are unreasonable in the average town or city 100 miles away and can not be maintained there.

Committees have resolved that salaries paid to engineers are too small and that they should demand more for their services. This interests another class of engineers, which includes many grades, and these, except perhaps in the higher salaried positions, are the ones who, if they were as earnestly striving to advance their own interests as most classes of people are at the present day, would get together and form associations, similar to labor unions, and demand better pay. They are prevented by a false sense of the dignity of a profession to which the majority can hardly be said to belong, as will be more fully set forth below.

Likewise, several codes of ethics have been carefully worked out and submitted to the more or less interested members of local and national organizations and to the fraternity as a whole. They are all good and will have a general good effect. Unfortunately such codes adopted by engineering societies so far have only been in the nature of recommended practice. There has been no attempt to enforce any of their provisions, as is done in the case of the lawyers, the doctors and the ministers. The only punishment that can well be inflicted is expulsion from some more or less restricted organization, and so far that has not been attempted, it is believed.

The expulsion of a member of even one of the great national engineering organizations would not have the effect of practically putting a man out of practice, as is the case in the legal, medical and clerical professions. Indeed in a great many cases it might not injure an engineer at all in the eyes of his clients.

If, for instance, the American Society of Civil Engineers, with headquarters in New York, most of its meetings held in that city, and with the majority of its rigidly selected membership residing in that vicinity, should discipline a member residing in Kalamazoo, Mich., who is popular with his clients, it might be a question which would suffer most in local prestige—the Society or the member from Kalamazoo. All this is not meant to discourage the adoption of codes of ethics, but to point out their limitations.

It is hard to induce legislators to pass laws restricting the practice of engineering. Many of them condemn such laws as prohibiting free opportunity, and therefore contrary to the American spirit. They may have had very little contact or acquaintance with engineers, and consider that if a man wants line and grade stakes set for a new building, or a system of farm drain tile laid out, he should be privileged to employ John Jones who, he knows, has never had a technical-school education, but who has been performing such services satisfactorily for his neighbors. Other legislators think they see an attempt at monopoly, of benefit only to those who are pressing for the legislation. And moreover any such legislation must have its inequalities and injustices, even though very careful provisions are made toward avoiding them.

However, it would seem that in legislation lies the only hope for placing of the profession of engineering upon its proper plane, and establishing it in the eyes of the people upon a level with the other learned professions. But we need to get down to basic conditions, and see things if possible from an outside viewpoint. It is best to go afield of engineering, for the point of view of the average engineer is sometimes thought to be not very broad, for the reason that his training and habits of thought are along mathematical lines.

Let us examine briefly conditions inside the three leading professions, so called.

Of these *the medical group* is perhaps the most thoroughly educated and its standing in the community, as a profession in the best sense of the word, is perhaps the highest. Nearly all doctors are good citizens and are looked up to as leaders in the community. They have a well recognized and admirable code of ethics.

*The clergy* have all degrees of education, from the highest to nearly the lowest, depending largely upon the requirements of the different denominations and locations. But, as a rule, the poorly educated clergyman finds himself so placed as to be as efficient among the people he serves as is the more educated one in his place. Owing to the nature of their calling these men are almost universally respected—although many of them have little part in the life of the community, at least beyond that portion of it which attends their own church. The layman, perhaps, observes no strong system of professional ethics among the churchmen, as they are naturally governed by the high system of ethics and morals which they are trying to impress upon the world at large. But we all can recall cases of effective discipline, both formal and informal, following conduct inconsistent with this high calling.

*The legal profession* is suffering from lack of education in many of its members, and the low standards of admission to the bar in many states, together with too much pernicious political activity, and other causes. Consequently, as a whole, this profession is not in as good repute as the others. There are great temptations to use an intimate knowledge of the technicalities of the statutes to circumvent the true spirit of the law. Such codes of ethics as the profession has do not strike at this and other acts which offend the moral sense of the people. Consequently, there has grown up a feeling of more or less distrust of the whole profession, and which is well summed up in such familiar expressions as, "A man does not go to law to get justice, but to get—what he can." This is not as it should be, and is somewhat enlarged upon here to show that this one of the three leading and longest established professions has as serious problems confronting it as has the engineering profession.

Looking out over the engineering field, conditions appear to be chaotic. In spite of all the efforts mentioned above, it seems most difficult to raise the standards of practice, the rates of compensation or the standing of engineers among their fellow men. It appears to the writer that a broader and really more sensible study should be made of the possible attack on this problem.

Let us compare the practice of engineering with that of medicine. Not everyone who practices medicine is a doctor, entitled to write "M. D." after his name, with all the learning, the skill, the governmental supervision that those letters imply. The drug clerk who recommends and sells one something to ease an aching tooth or heal a bruise is performing true medical service. The housewife, with her simple skill and homely but efficacious remedies, practices medicine. The faithful nurse, who is given a considerable amount of discretion by the doctor and who is expected to act in emergencies during his absence, must be conceded to be a medical practitioner to that extent. All these and many others have an important part in treating human ills, but only the doctors, the "M. D.'s," belong to the medical *profession.*

We find, in turning to the practice of law, that the average business man tries to be well enough posted on legal principles to steer clear of entanglements. Lawyers' clerks, notaries, justices and others draw up legal papers and handle minor cases. Corporation claim agents seek to adjust legal claims. These and many others handle legal matters, but only the lawyers, admitted to the bar and licensed to represent others in court, are generally considered as belonging to the legal *profession.*

So in the profession of theology, it may be said without irreverence that we are all enjoined to minister to the wants of others in a humble way, and to inculcate principles of right living, but only the clergy, licensed and ordained, belong to the sacred *profession.*

In seeking to place the *engineering profession* upon the same high plane as these other three professions, it seems as if we lose sight sometimes of the fact that similar conditions exist in the practice of engineering. The attempt should not be made to gather everyone who, in a limited way, practices engineering or who may be called an engineer into the *profession* of engineering.

The young man, whether technically educated or not, who has charge of the construction of a piece of sewer work, for instance, will seldom be regarded by the public as a professional man, although he may be fitting himself for professional work later on. Neither will the young college graduate employed as instrument man, under the direction of a chief of party; he should be rated as a high-class mechanic, and is usually so considered by men of affairs.

Other classes which should not be included in membership in the profession which readily come in mind are the ordinary surveyor, the draftsman (unless he be a designer), the commercial engineer (who uses his knowledge as an aid to salesmanship only), the engineer holding an executive position (in most instances), most engineering contractors and some contracting engineers (if we may be allowed to make the distinction), technically educated but not trained men (that is, men who have had an engineering education but who have not put it into practice outside of a class room).

It would seem as though all the consulting engineers, the engineers in private practice, and all others who think themselves entitled to call themselves professional men according to the above standards should get together, under the leadership perhaps of the American Institute of Consulting Engineers, and work up the subject along these lines: (1) Provide for some distinguishing title, such as "Consulting Engineer," or degree, like "D. E.," or better perhaps, "D. C. E.," or "D. M. E.," etc.; (2) arrange for awarding of these degrees from within; (3) draw up and enforce a code of ethics and rules of professional conduct, modeled after the physicians', especially as regards consultation with experts in the most important cases and in work out of the ordinary.

Mention has been made of the difficulties that have been met with in trying to secure legislation. It would seem at the start inexpedient to attempt much in this line, but, as an entering wedge, a brief act providing a considerable penalty against a person who hangs out a sign with the letters "D. C. E.," for instance, after his name, or who falsely represents himself so to be, would seem to be of such a nature as to receive favorable consideration by the average legislature. The enforcement of such an act would be of great benefit from the start, and additional legislation should be less difficult to secure as time passes and the engineering profession gradually establishes itself in the eyes of the people.

E. H. Cowan,
Engineer and Contractor.

Taylorville, Ill., Feb. 3, 1913.

## NOTES AND QUERIES

The Report of the Joint Committee on Concrete and Reinforced Concrete, reprinted in part in our issue of Feb. 6, 1913, p. 258, has several errors in the formulas (given on our p. 263), which were copied into our abstract. The corrections are as follows:

After equation (2) substitute j for k so that the line now reads "(For $f_s$ = 15,000 to 16,000, and $f_c$ = 600 to 650, j may be taken at ⅞.)"

In equation (4), last term, j should be omitted so that equation now reads

$$f_c = \frac{2\,M}{jkbd^2} = \frac{2\,p f_s}{k} \qquad (4)$$

In equation (12), second term of numerator, $t^2$ should be $t^3$. Equation then reads

$$s = \frac{\left(kdt^2 - \frac{2}{3}t^3\right)b + \left[(kd-t)^2\left(t + \frac{1}{3}(kd-t)\right)\right]b'}{t\,(2\,kd - t)\,b + (kd-t)^2\,b'} \qquad (12)$$

# The Program for Completion of Culebra Cut*

Dry excavation in Culebra cut will be carried forward in accordance with the following program:

The lake level will be brought up to +50 by July 1, 1913. On and after July 1, the lake will be permitted to rise continuously, and steamshovel work in the cut can continue as long as the height of the Gamboa dike will suffice to hold back the water of the lake. The top of the dike is about elevation +78. Inasmuch as with a season of average rainfall, an elevation of +74 may be expected to be reached about Oct. 10, the dry excavation may be continued in the Cut until Oct. 1, 1913. It may be necessary to flood the cut at any time thereafter. This program has been laid out so as to obtain a lake elevation of 85 ft. above sea level on Dec. 1, 1913, and in accordance with it, Gorgona Shops will be flooded out about Sept. 15.

On Feb. 1, there had been dug out of Culebra cut 88,592,307 cu.yd. of rock and earth, and there remained to be excavated approximately four million cubic yards not including present slides. The work is now practically confined to three out of the nine miles of the Cut.

The section in which the work is being carried on is from a point near Empire, to a point near the old hamlet of Cucaracha, about one-half mile north of Paraiso. This includes the channel in front of Empire, Culebra, Rio Grande, Gold and Contractors' Hills, and a short distance south. In accordance with the original plans the work is being prosecuted so as to keep the highest point in the Cut somewhere about half way between the ends to assist in drainage, and to make it possible for loaded spoil trains to run down grade in going through the Canal. The summit in the pioneer or lowest cut is now about opposite the administration building at Culebra, and here the excavation is down to 61 ft. above sealevel, 21 ft. above the bottom of the Canal. The drainage is continued as heretofore, through the main culvert of Pedro Miguel Locks on the south end, and into the sump at Gamboa at the north end whence it is pumped into the Chagres.

At present 37 steamshovels are at work, and when emergency demands some of them are run on double shift, making twelve hours a day. The daily excavation in January averaged over 50,000 cu.yd., and this is being maintained at the present time. The equipment engaged in hauling the spoil includes 124 locomotives 1512 flat cars of 19 cu.yd. capacity, 199 steel dump cars of 17 cubic yards, and 136 dump cars of 10 cubic yards capacity. In blasting work 359 drills are employed, and in January 396,250 lb. of dynamite were used; about 0.35 lb. per cu.yd. of material excavated.

### The Slides

Although there is nothing new in the manner of the development of the slides on either bank of Culebra Cut, they have shown unexpected activity during the past few weeks. The theory once held, that these movements of the banks toward the Canal were more likely to occur in the rainy reason than in the dry, was abandoned a year ago when the most notable slides of the year occurred in the dry season.

The latest movement of a large amount of material occurred on the night of Feb. 4, when a pocket of earth and loose rock on the east bank opposite Hodges Hill at Culebra settled downward and moved 80 ft. into the Canal. The movement began about 9 o'clock and continued two hours, in which time the bank sank in places as much as 60 ft. The break is 1000 ft. long across the face toward the Canal, and extends back 680 ft. from the face of the bottom slope. A steamshovel was moved toward the center of the Canal, and three railroad tracks were temporarily blocked. The break in the bank that indicated a probable slide at this point was noted two months ago, but the movement was unexpected at this time. Apparently it is like a large number of other slides, merely a loose mass of rock and earth moving on an underlying surface of rock that dips toward the Canal. The toe of the slope having been dug away, the mass moved of its own weight. It is estimated that two million cubic yards are in motion here, although this is largely conjectural, because it is not known on what slope the material is moving. Two steamshovels are digging out this slide.

A survey of the old slide at Cucaracha, which has resumed activity recently, was made last week. It is estimated that from two to three million cubic yards of material are now in motion here, but this also is subject to the qualification made above. On the other hand it is not believed that all of this material will move into the Canal. Five steamshovels are now at work there. One day last week one of these was put out of service temporarily when the material it was digging flowed about it and covered the loading tracks. It was extricated within 24 hours, and is again at work. Incidents like these have become part of the day's work in Culebra Cut and the men have become so accustomed to meeting such emergencies that delays on account of them are continually growing less.

A 95-ton steam shovel is being so altered that it can lift spoil 21 feet above the track on which it is standing and load it into cars. This is necessary for the purpose of handling material to advantage in Cucaracha slide.

The bench on which the shovel will work through the sliding material is 40 feet above sea level, and it is necessary for it to load upon cars that are on a bench 57 feet above sealevel. The floor of the flat car is three feet above the track, so that the total lift is 20 feet. Shovels of this class now load 17 feet above the level of the track on which they stand. The alterations consist of extending the boom 21 inches by adding two 15-inch I-beams, and arranging the sheaves upon them as sisters instead of tandem, as at present; lengthening the dipper stick six feet making it 24 ft. 6 in. long; and fixing upon it a 3-yard instead of a 5-yard dipper.

*From the "Canal Record," Feb. 12, 1913.

# Recent Cucaracha Slides, Panama Canal

The accompanying illustration shows the slide which occurred on Jan. 16 at Cucaracha on the east bank of the canal just south of Gold Hill, described in a note in our issue of last week. It will be remembered that this slide carried the earth clear across the canal prism, choking

PHOTOGRAPH OF THE CUCARACHA SLIDE OF JAN. 16 AND 17, CULEBRA CUT, PANAMA CANAL
(Copyright by Underwood & Underwood, New York City)

all five railway tracks. This slide proper contains only about 400,000 cu.yd., but its giving way was the indirect cause of further slides which will involve an additional amount of excavation estimated at over 1,000,000 cu.yd.

The Cucaracha slides have been a source of constant trouble and delay ever since the days of the French canal company. No sooner had the American engineers taken hold of the work in 1905 than they too commenced to experience difficulties. Between 1905 and July 1, 1912, nearly 3,000,000 cu.yd. of extra excavation have been necessitated by slides at this point, which had, at that time, already covered an area of 47 acres and had broken back nearly 1900 ft. from the canal center line. These slides have been due to the slipping of the top layer of clay and earth on a smooth sloping surface of harder material.

A report on the nature and geology of the slides appeared in ENGINEERING NEWS, Nov. 28, 1912, p. 1021.

# Notes from a Traveler in Mexico

On account of the recent startling events in Mexico, the following extracts from personal letters of a representative of the Hill Publishing Co., now traveling in Mexico, are of interest.

(Feb. 9, at Tepeixco Camp.) From 1:30 p.m. to 5:30 p.m. I drove 20 miles in a single-seated buckboard, drawn by three mules, containing mail, express, two Mexicans and myself. Had a delightful drive through pine woods and through fields of maguey cactus—everything green, luxuriant vegetation—strange for Mexico! Turkeys, turkeys everywhere, but all too tough to eat? Everything quiet and peaceful. It is hard to believe that this fair, sunny, beautiful country is torn with civil war and bloodshed. No news from Mexico City since noon. The telephone line is working to the Nonoalco plant on the edge of the city, but not to the center of city and main office. Report at 1 p.m. was that firing had stopped. Cannon balls were falling around the Nonoalco plant in the morning. As yet, foreigners have not been bothered.

Events in Mexico City are sole topics of conversation. All women in these camps were ordered by the company to leave before Feb. 4. Most of them are in the United States, but some are in Mexico City. Some of the fellows are talking of packing grips so as to be ready to leave. The company has a stand of 19 army rifles. Tonight the men are learning how to load and aim them. My grips are in New Porter's Hotel; I hope they don't break in there—glad I am out here in a tent. I think the trouble will be all over by Tuesday night, when I get back to the city. It does not worry me a bit, only this may knock my business in the head.

(Feb. 10.) Morning spent at Camp Tepeixco—22 miles from railroad. In the afternoon walked over the mountains to Camp Quacuenella. It was only four miles, but I had to climb over two mountains that were over a thousand feet above the camp. There the superintendent dressed me up in rubber hat, slicker, and hip boots so big I had to hold them on, and then he took me into tunnel No. 17, a distance of one mile to the "face." They work without a shield; a jet of water spouts from every drill hole, running a measured 700 gal. per min. Saw an underground stream as big as my leg spouting out. Reminded me of John Burroughs' essay on "Springs." The face of tunnel was 1000 ft. ahead of the concrete and timbering. They have trouble with this water; the work was very interesting, though not so much so as the trip I took five years ago into the Detroit River tunnel under 28 lb. air pressure. Men on this job here came from the Pennsylvania R.R. tunnel in New York.

(Feb. 11.) I spent from 5 to 10:30 a.m. in a three-mule buckboard going from Tepeixco to Corinea. From 1 p.m. to this hour (3 p.m.) have been en train for Mexico City. Fierce rumors. Guess they are fighting today (though at Corinea last night we had a false report of battle).

I hear that street cars and taxis are not running in the city. A few cabs or "coaches" are said to be going, though hard to get, and they charge four to ten times ordinary rates. Reports are also that the city is surprisingly orderly with no anti-foreign feeling. I have noted very little unfriendly feeling and feel perfectly safe. There is a nervy bunch of Westerners here; the New Yorkers are going home.

(Two hours later.) We are now 1 hour late; waited at a junction for a carload of soldiers. It would make you laugh to see them. Most of them carried a game cock tied up in a piece of cloth, head and tail sticking out. Several had on their shoulders some kind of an animal with a long nose—a sort of raccoon I think. One led a dog. With them were quite a number of women with packs on their backs and chickens in their arms. That is their commissary department. (This train jolts worse than the Vermont Central—it is a tiny branch line.)

Don't worry about me. Have plenty of money. Have on me $167 in U. S. Gold—most of it next my hide under my garter. They will have to strip me to find it. Have a 32-cal. Colt automatic in shoulder holster under my arm—well hidden so they won't find it and take it away. Have never had any trouble and do not expect any.

(Mexico, City, Feb. 12.) The hack man last night at station said he could not drive across city to this hotel, but finally ended by making it as the firing had ceased. The street cars are standing where they stopped, and the city was strangely quiet. Few people were on the street: those that were out were standing in little groups talking—are very orderly and quiet. No police were in sight. These peons seem to deserve great credit for their behavior.

I walked all over from 8:30 to 11 p.m. The Government forces are on the West end of Alameda (3 blocks from here—only 1 block to the Alameda North). They permit citizens to approach to the lines but no farther. Federal machine guns are located in this street, two blocks south of this hotel to sweep the street at right angles to this one.

Also walked down San Francisco St. to within one block of the Zocalo or Main Plaza. Rurale outposts stop you at all corners, one block from the Zocalo. There is no anti-foreign feeling—no one even looked at me. Americans are treated with all respect.

This hotel is in line between the Government Palace at Zocalo (where Madero is) and the Cuidadela or Arsenal (where Diaz is) but it is out of the direct line of fire unless the forces move up.

A big bomb just burst in this street in the next block. Piece of bomb and some bullets dropped in the street in front of this hotel. Boys grabbed them before they stopped rolling. Sounds like 4th of July outside. I have seen no dead horses or dead men—report was that streets were full of them. But I was not permitted by soldiers to go on the streets where fighting occurred yesterday.

Firing started at 7:10 a.m. Quite interesting in town; glad to be here.

(Pachuca, Hgo., noon, Feb. 13.) The papers give sinister reports about preparations of the United States. There was no anti-American feeling shown in Mexico City. I was on the street alone, and at times with one American, two evenings and most all of yesterday. This morning we walked to the depot through two miles of the toughest part of the city, with no police on the streets, and no one even looked at us. It is surprising how well behaved the peons are; they do not seem to like either side of the difficulty and remain neutral. There was an anti-American demonstration in Pachuca last week (which caused me to visit Necaxa first) but it is over and quiet now.

R. B.

## NOTES FROM THE ENGINEERING SCHOOLS

The engineering schools of the land-grant universities and colleges of the United States on Jan. 24, at Washington, D. C., formed an association to deal with problems peculiar to such institutions (by reason of the land-grant act of Congress under which they were established) and to coöperate with the agricultural association of the same colleges, which has been active for many years. The membership of the new association comprises the presidents of these institutions, the deans of the engineering schools in them and such other representatives as each president may select. A single vote is allowed to each state school represented. The U. S. Bureau of Education has a right to representation and one vote. About two-thirds of the states were represented at this first meeting by their deans of engineering or presidents. The U. S. Commissioner of Education and part of his staff were present. The following officers were elected: President, J. P. Jackson, dean of the school of engineering at Pennsylvania State College; Vice-President (*ex-officio*), T. P. Claxton, U. S. Commissioner of Education; Secretary-Treasurer, A. Marston, dean of the engineering department of Iowa State College. The executive committee consists of the foregoing and the following: W. M. Riggs, president of Clemson Agricultural and Mechanical College of South Carolina; H. W. Tyler, professor of mathematics of the Massachusetts Institute of Technology; A. W. Smith, dean of Sibley College at Cornell University; G. W. Thistle, dean of the engineering department of Michigan Agricultural and Mechanical College. C. H. Benjamin, dean of the school of engineering at Purdue University, was appointed chairman of a committee which is to be continued through the year to consider the public relations of institutions of this class.

STEVENS INSTITUTE OF TECHNOLOGY—The Alumni Association of this Institute held a dinner at the Hotel Astor, New York City, on the evening of Feb. 14 to celebrate the completion of ten years of service by Dr. Alexander C. Humphreys as President of the Institute. Out of some 1500 living graduates of the Institute, nearly 700 were present at the dinner. There were also present as invited guests a large number of prominent engineers and engineering educators. E. H. Peabody, of the class of 1890, acted as toastmaster and succeeded in enforcing a five-minute rule upon the dozen after-dinner speakers by the expedient of having the lights on the large electroliers in the center of the ball room automatically dimmed when each speaker's five minutes' interval expired.

Among the speakers were Dr. Palmer C. Ricketts, Director of Rensselaer Polytechnic Institute; Dr. Henry S. Pritchett, President of the Carnegie Foundation; Prof. Chas. F. Kroeh, who still holds the chair of modern languages at Stevens Institute and is the only one remaining of the original faculty of the Institute at its foundation in 1871. Dr. Humphreys in his address referred briefly to the plans of the Institute for enlarging its lands and facilities on its new site at Castle Point, Hoboken.

OREGON AGRICULTURAL COLLEGE—An annual engineering show has recently been given at this institution by the students in civil, electrical and mining engineering departments, and in the school of forestry. The uses of electricity were shown, including a wireless telegraph station, which attracted great attention. Communication was established between this and every station on the Pacific Coast from Alaska to San Diego, and with the Hawaiian Islands and ships at sea. There were shown also methods of irrigation, fire fighting, and forest surveying, highway construction, the construction of farm buildings and equipment. The funds received from the show are used to support a monthly student magazine.

OHIO STATE UNIVERSITY—A two weeks' winter course in highway engineering is to be given from Feb. 24 to Mar. 8, under the auspices of the Civil Engineering Department of the College of Engineering in coöperation with the State Highway Department and the Ohio Good Roads Federation. The program shows 42 items, four of which are inspection trips, two are laboratory demonstrations, two are meetings for the discussion of questions which the visitors desire to have answered, and one is a symposium on patent and proprietary materials or processes; these are in addition to lectures on the economics and engineering of roads in general, on various types of construction, on the various kinds of materials locally available, on the preparation of sub-grades, the construction of culverts, bridges and foundations, on legislation, foreign practice, maintenance, etc. It is expected that two classes of men will attend these lectures and they have been arranged to appeal to both. One class will be men having an engineering training and some experience in road construction; the other class will be men without an engineering training, but who need information about material, construction and maintenance, and the methods of securing economical and efficient work.

In addition to the regular teaching staff of the university, well known specialists have been secured for lectures. Each lecture will be one hour long, and is to be followed by a 45-min. discussion.

**Synchronizing the Talking and Motion Picture Machines** has been accomplished in a new invention of Thomas A. Edison. The Kinetophone, as this latest amusement machine is called, was demonstrated in five theaters in New York City on Feb. 17 and was reported to be a complete success.

**The Bursting of a Centrifugal Drier** in the plant of the Park Woolen Mills, at Rossville, Tenn., on Feb. 20, killed one and injured two other mill employees. The regular operator on the extractor is reported to have opposed an increase of steam pressure on the machine, claiming that it was working at its maximum safe speed. When the pressure was raised this man ran from the machine and escaped injury.

**A Block on the New York Subway** on the evening of Feb. 18 tied up part of the system for two hours, between 8 and 10 p.m. A broken brake-shoe on a north-bound train, in the West Farms branch, flew against the third-rail and caused a short circuit.

**A Conflagration in Tokio, Japan,** on Feb. 19, is reported to have consumed 3000 buildings and made 15,000 people homeless, and destroyed property worth $2,500,000.

**The Railway Valuation Bill** now pending in Congress passed the Senate on Feb. 24. It had previously passed the House. Some differences in the bills passed by the two houses will require a conference, but it is stated that the bill passed the Senate with little opposition and the probabilities are that it will become a law before the end of the session. The bill requires the Interstate Commerce Commission, through a corps of expert engineers, to value the property of all railways, telegraph and telephone companies and other common carriers, to determine the amount that has been expended upon the properties, the cost of their reproduction at the present time, the value of all properties now held by them, and the value of all their intangible property such as franchises and good will.

**A Reinforced-concrete Roof** over a moving picture theater in course of construction at 16th Ave. and Bergen St., Newark, N. J., collapsed for a portion of its area on Feb. 15, 1913, shortly after a number of laborers who were working under it had left. The roof was a flat concrete slab spanning between the wall and a girder 12 ft. back from the wall and was reinforced with straight rods. Although a larger portion had recently been cleared of its supporting struts, the fallen section was only about 40 ft. long. Apparently the design was not over safe and the set of the concrete had been retarded by the cold weather. The forms had been removed two days before the failure but there had been freezing weather up to the day of the collapse, when the temperature became quite warm. The inspector of buildings has ordered the removal and reconstruction of the entire roof.

**A Profit-Sharing Plan** has been placed in operation by the architectural and engineering firm of Ballinger & Perrot, with offices in New York and Philadelphia. Profit sharing has been practiced by this firm in the past to the extent of alloting a certain portion of the net profits to the heads of the several departments. This has proved so satisfactory that it has been decided to extend the plan to all employees. The firm makes no pretense that this plan is a philanthropic one but merely states that, in its experience, it results in mutual benefit to employer and employee and increases the efficiency of the entire working force.

The new plan is worked in two ways. First, there will be a division of a certain sum set aside from the profits, in which all employees will share equally, irrespective of their salaries. Secondly, there will be a division of an additional amount set aside from profits, an allotment being in proportion to the ratio of an employee's salary to the total salaries paid.

## PERSONALS

Mr. L. I. Stone has been appointed Assistant Engineer of the Grand Trunk Ry., with headquarters at London, Ont.

Mr. H. H. Gibson has been appointed Chief Engineer of the New Orleans Southern & Grand Isle Ry., at Algiers, Ala.

Mr. James Boyd has been appointed Assistant Engineer of the Grand Trunk Ry., with headquarters at Hamilton, Ont.

Mr. W. A. Siegner has been appointed Assistant Engineer of the Grand Trunk Ry., with headquarters at Stratford, Ont.

Mr. H. A. Palmer has been appointed Assistant Engineer of the terminal division of the Grand Trunk Ry., with headquarters at Toronto, Ont.

Mr. J. G. Sheldrick, until recently Resident Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Ry., at Superior, Wis., has been promoted to be Division Engineer at Superior.

Mr. H. R. Carpenter, formerly Assistant Engineer of the Missouri Pacific Ry., at St. Louis, Mo., has been promoted to be Engineer of Maintenance-of-way, with headquarters at St. Louis.

Mr. Frederick H. Hammill, recently Division Superintendent of the Chicago & Northwestern Ry., at Boone, Iowa, has been promoted to be Assistant General Superintendent, with headquarters at Boone.

Mr. A. Syverson, formerly Trainmaster of the Chicago & Northwestern Ry., Belle Plaine, Iowa, has been appointed Superintendent of the Ann Arbor R.R., at Owosso, Mich., succeeding Mr. W. D. Holliday, resigned.

Mr. C. E. Hix, recently Car Accountant of the Seaboard Air Line Ry., at Portsmouth, Va., has been appointed Superintendent of Transportation, succeeding to the duties of Mr. J. M. Shea, General Superintendent, resigned.

Mr. E. S. Heyser, formerly Trainmaster and Roadmaster of the St. Louis, Brownsville & Mexico Ry., at Kingsville, Tex., has been appointed General Superintendent of the San Benito & Rio Grande Valley R.R., at San Benito, Tex.

Dr. Ernst J. Berg, M. Am. Inst. E. E., for the past four years Professor of electrical engineering at the University of Illinois has been appointed Professor in charge of the electrical department of Union College, Schenectady, N. Y.

Mr. F. J. Byington, Assistant Division Superintendent of the Chicago & Northwestern Ry., at Baraboo, Wis., has been promoted to be Division Superintendent at Boone, Iowa, succeeding Mr. Frederick H. Hammill, promoted, as noted elsewhere.

Mr. A. W. E. Fawkes, recently connected with the construction of the mechanical filtration plant of the Minneapolis, Minn., water-works, described in our issue of June 27, 1912, is now Engineer in charge of the water-works of Calgary, Alta.

Mr. S. J. Van Ornum, Assoc. M. Am. Soc. C. E., recently City Engineer of Pasadena, Calif., has opened an office in the Pacific Bldg., San Francisco, Calif., as a consulting engineer, specializing in reinforced-concrete construction and municipal work.

Mr. W. G. O'Malley, for a number of years General Master Mechanic of the Lackawanna Steel Co., Buffalo, N. Y., has accepted a position with the Pittsburgh Crucible Steel Co., in connection with the building of their new plant at Midland, Penn.

Mr. H. H. Eggleston has resigned as Assistant Supervisor of Bridges and Buildings of the Baltimore & Ohio Chicago Terminal R.R., at Chicago, Ill., to become Supervisor of Bridges and Buildings of the Chicago Great Western Ry., at Des Moines, Iowa.

Mr. H. B. Holmes has been appointed Resident Engineer of the Kansas City, Mexico & Orient Ry., at Kansas City, Mo. Mr. Holmes succeeds to the duties of Mr. W. W. Colpitts, M. Am. Soc. C. E., Chief Engineer, resigned, as noted in our issue of Feb. 6. The position of Chief Engineer has been abolished.

Mr. George M. Brown, a civil engineer, of Princeton, N. J., has been appointed Superintendent of Public Works of Princeton, a newly created office. The office combines the former ones of Street Commissioner and Borough Engineer. Mr. Brown is a graduate in civil engineering of Princeton University.

Mr. A. B. Warner, Engineer of Maintenance-of-way of the Chicago, Rock Island & Pacific Ry., at El Reno, Okla., has been appointed Superintendent of the Chicago, Rock Island & Gulf Ry., with headquarters at Fort Worth, Tex., succeeding Mr. C. L. Ruppert, transferred to El Reno, to succeed the late J. McGle.

Mr. W. T. Main, recently Division Engineer of the Chicago & Northwestern Ry., at Chicago, Ill., has resigned to engage in private practice. He is succeeded at Chicago by Mr. S. S. Long, formerly Division Engineer at Madison, Wis. Mr. W. J. Jackson, Division Engineer at Antigo, Wis., has been transferred to Madison to succeed Mr. Long.

Dr. E. G. Acheson, of Niagara Falls, N. Y., inventor of carborundum, siloxicon, a method of making graphite and other abrasives and lubricants, has been decorated by the Czar of Russia with the Order of St. Ann, an order established in 1797 by the Emporer Paul I and ranking high among the various orders of nobility of European governments.

Mr. J. A. Somerville, Superintendent of Terminals of the Missouri Pacific Ry., at St. Louis, Mo., has been promoted to be Superintendent of Transportation of the Missouri Pacific and the St. Louis, Iron Mountain & Southern Ry., with headquarters at St. Louis, Mo., succeeding Mr. E. [illegible], recently promoted to be General Superintendent of Transportation.

Mr. Edgar S. Closson, Assoc. M. Am. Soc. C. E., recently Assistant Engineer, Public Service Commission of New York, First District, has been appointed Town Supervisor of Montclair, N. J., in charge of engineering and public works. Mr. Closson graduated from Union College, Schenectady, N. Y., in 1906, and for several years has been engaged in survey work on the New York City subways.

Mr. R. S. Buck, M. Am. Soc. C. E., recently appointed Chief Engineer of the Dominion Bridge Co., Montreal, Que., was Chief Engineer of the Manhattan and Queensborough bridges, New York City, from 1899 to 1902, and not of the Williamsburg bridge, as stated in our issue of Feb. 6. Mr. Buck was Consulting Engineer in charge of the same bridges from 1904 to 1907, but not Chief Engineer of the Department of Bridges, as erroneously stated.

Lieut.-Col. William V. Judson, Corps of Engineers, U. S. A., Engineer Commissioner of the District of Columbia, has been assigned to duty on the Panama Canal under Col. Goethals. He is succeeded as Engineer Commissioner by Maj. Chester Harding, Corps of Engineers, U. S. A., at present Assistant to Col. Sibert, Division Engineer of the Atlantic division of the Panama Canal. Maj. Harding was Assistant Engineer Commissioner of the District of Columbia from 1901 to 1906.

Mr. Ralph Budd, recently appointed Assistant to the President of the Great Northern Ry., has been appointed Chief Engineer of the Great Northern Ry., succeeding Mr. A. H. Hogeland, M. Am. Soc. C. E., who has been appointed Consulting Engineer. Mr. Budd was appointed Chief Engineer of the Spokane, Portland & Seattle Ry. in 1910, and had charge of the construction of various extensions of the Hill lines in Oregon, including the Oregon Trunk Ry. He was appointed Assistant to the President of the Great Northern Ry., on Jan. 1, last.

Lieut.-Comdr. R. H. Robinson, Naval Constructor, U. S. N., has resigned to become associated with the Lake Torpedo Boat Co., of Bridgeport, Conn. Naval Constructor Robinson graduated from the United States Naval Academy, at Annapolis, in 1892. He studied naval architecture at the University of Glasgow, Scotland. During the Spanish-American War he had charge of the refitting of the transatlantic steamers "St. Louis" and "St. Paul" into scout cruisers. He has been actively engaged in the design and construction of 12 American dreadnaughts, built or building. Naval Constructor Robinson is the twelfth member of the navy construction corps to accept positions with shipbuilding firms during the past 15 years.

The Canadian Pacific Ry. has established a new engineering grade of Division Surveyor. The duties of this position will include the preparation of plans and descriptions for purchases, sales and leases of land, resurveys of right-of-way, and such other land-survey work as comes within the jurisdiction of the operating and maintenance departments and not connected with construction work. The appointments to these positions are made by the right-of-way and lease agent with the approval of the various division superintendents. The following appointments have been made: Mr. A. P. Walker, M. Can. Soc. C. E., formerly Assistant Division Engineer at Toronto, to be Division Surveyor of the Ontario division with headquarters at Toronto, Ont.; Mr. G. E. Fiset, Assoc. M. Can. Soc. C. E., Division Surveyor of the Eastern division at Montreal, Que., and W. A. Sibbett, Division Surveyor of the Lake Superior division with headquarters at North Bay, Northern Ontario.

Mr. Clinton L. Bardo, recently Assistant to the General Manager of the Lehigh Valley R.R., at South Bethlehem, Penn., has been appointed General Manager of the New York, New Haven & Hartford R.R., at New Haven, Conn., succeeding Mr. B. R. Pollock, resigned, as noted in our issue of last week. Mr. Bardo's railway experience dates from 1885, when he entered the service of the Pennsylvania R.R. as a telegraph operator. Later he became Assistant Trainmaster of the Lehigh Valley R.R., and in 1901 was made Trainmaster of the New York division of that railway. Three years later he was appointed Freight Trainmaster of the New York, New Haven & Hartford R.R., at New York City, becoming Superintendent of the New York division in 1905. In 1907 he was appointed Superintendent of the Grand Central Station and of the Electric division of the New York Central & Hudson River R.R., which position he resigned in 1911 to become Assistant to the General Manager of the Le-

high Valley R.R. He will also be General Manager of the Central New England R.R.

Mr. A. H. Hogeland, M. Am. Soc. C. E., Chief Engineer of the Great Northern Ry. since 1903, has retired from the position of active head of the engineering department to become Consulting Engineer of the company. Mr. Hogeland was born in Pennsylvania in 1858 and graduated in civil engineering from Lafayette College in 1877. He began his railway experience as a rodman and leveler on surveys and construction of the St. Paul & Pacific Ry. in 1879. From 1880 to 1882 he was leveler, transitman and topographer on the location surveys for the Yellowstone and Rocky Mountain divisions of the Northern Pacific Ry. The following eight years Mr. Hogeland spent as Assistant Engineer on the construction of the Northern Pacific and Great Northern Rys. in Minnesota, N. Dakota, S. Dakota and Montana. From 1890 to 1896 he was Engineer of Maintenance-of-way of the Eastern district of the Great Northern Ry., and from 1896 to 1902 Resident Engineer of the same district. In 1902 he was promoted to be Assistant Chief Engineer and in February, 1903, to be Chief Engineer.

## OBITUARY

George Yale, Mechanical Engineer of the Montreal, Que., Harbor Commissioners, died at his home in Montreal, Feb. 8, at the age of 60 years. He had been with the Harbor Commissioners for the past six years.

Henry Hauser, President of the H. Hauser Contracting Co., died recently at his home in Los Angeles, Calif. Mr. Hauser went to Los Angeles in 1900. For several years he was connected with the Lanty-Shary Contracting Co., and supervised railway construction throughout the West.

Sir William Arrol, head of the firm of William Arrol & Co., Engineers, of Glasgow, Scotland, died in London, Feb. 20, aged 74 years. The firm of William Arrol & Co. has been contractor for many famous English bridges and is perhaps the leading bridge building concern in England. The fame of the firm rests chiefly on the construction of the Firth of Forth Bridge.

William Riley McKeen, President of the Terre Haute & Indianapolis R.R. (now the Vandalia R.R.) for nearly 30 years, died at his home in Terre Haute, Ind., Feb. 18. He was born on Oct. 12, 1829, in Indiana. He was a delegate to the Republican National Conventions of 1872 and 1904 and active in the public life of his community. Mr. McKeen was the father of Benjamin McKeen, M. Am. Soc. C. E., recently promoted to be General Manager of the Pennsylvania R.R. Lines West of Pittsburgh, and of W. R. McKeen, Jr., M. Am. Soc. M. E., President and General Manager of the McKeen Motor Car Co., Omaha, Neb., and formerly Superintendent of Motive Power of the Union Pacific R.R.

Frank Soulé, M. Am. Soc. C. E., President Emeritus of civil engineering at the University of California, died at his home in Berkeley, Calif., Feb. 14. Prof. Soulé was born in Woodville, Miss., in 1845. He graduated from the United States Military Academy at West Point in 1866, and after serving as an ordnance officer and as an instructor in ordnance and gunnery at West Point, he resigned his commission in the army and went to California, where he became Professor of mathematics at the University of California in 1869. Later he was Professor of civil engineering and Dean of the college of civil engineering. He retired several years ago, but had practiced extensively as a consulting engineer.

William Bostwick Stilson, for many years a prominent railway engineer, died at his home in Oswego, N. Y., Feb. 12. He was born in New Milford, Conn., in 1842. He graduated in civil engineering from the Rensselaer Polytechnic Institute in 1867. For many years he was employed in the building of several important railways in the East and South. He was Engineer on location and construction for the New York & Oswego Midland R.R., now the New York, Ontario & Western Ry.; the Erie R.R. and the Shenandoah Valley R.R. From 1881 until his retirement in 1909, on account of ill health, he was Assistant Engineer for the Michigan Central R.R., at Detroit, Mich. Mr. Stilson is survived by a widow, a daughter and three sons.

Albert S. Cheever, M. Am. Soc. C. E., for several years Superintendent of the Fitchburg division of the Boston & Maine R.R., died at his home in Somerville, Mass., Feb. 17. Since December of last year Mr. Cheever had been engaged in special work in the operating department as Assistant to the General Manager. He was born in Chelsea, Mass., Sept. 17, 1857. He entered the railway service in 1880 as a clerk in the General Superintendent's office of the Fitchburg R.R. The following year he was transferred to the Chief Engineer's office and held various subordinate positions until 1886 when he was promoted to be Assistant Engineer at Fitchburg, Mass. In 1887 he was made Division Engineer and held this office until 1890, when he was promoted to be Chief Engineer. Upon the absorption of the Fitchburg R.R. by the Boston & Maine R.R. in 1900, Mr. Cheever became Assistant Chief Engineer of the latter railway. He was appointed Superintendent of the Fitchburg division in 1902.

Carl Gustaf Patrik de Laval, inventor of the turbine which bears his name, died recently at the age of 67 years. His famous turbine was the outcome of an invention for separating fluids of different specific gravities by means of a centrifugal machine. This was made in 1878 when de Laval was 34 years old. In 1883 he invented a power separator and in 1884 a special form of bearing for steam engines in which centrifugal force was adapted to suck the oil into the bearing instead of throwing it out. The first de Laval turbine was brought out in 1889, and the inventor lived to see its successful introduction into many countries. Although known chiefly for his invention of centrifugal cream separators and turbines de Laval's activities were by no means confined to these machines. He devised, while still a young man, a method of producing sound steel ingots by providing a cap of non-fusible material to fit the top of the ingot mold; other inventions were in connection with the smelting of metals by electricity, the manufacture of metal pipes, a milking apparatus, boiler, furnaces, and a great many other things. Dr. de Laval was a native of Sweden and made his home in Stockholm.

George Washington Custis Lee, an officer of the Corps of Engineers, U. S. A., before the Civil War and later an engineer officer of the Confederate Army, died at his home in Ravensworth, Va., Feb. 18. Gen. Lee was a son of Gen. Robert E. Lee, Commander-in-Chief of the Confederate Army, and a grandson of Gen. Henry Lee, the "Light Horse Harry Lee," of Revolutionary fame. He was born at Fort Monroe, Va., Sept. 16, 1832. He graduated from the United States Military Academy at West Point in 1854. After receiving his commission in the Corps of Engineers he saw service in Florida, Georgia, San Francisco and Washington, D. C. At the beginning of the Civil War he resigned his commission and was shortly afterward appointed Captain of Engineers in the Confederate Army. He constructed the fortifications around Richmond, Va., and served as an aid on the staff of the President of the Confederacy. Later he was commissioned Brigadier-General, and toward the close of the war, Major-General. In 1865 Gen. Lee accepted the office of Professor of civil engineering at the Virginia Military Institute at Lexington, Va. Upon the death of his father, Gen. Robert E. Lee, he succeeded to the presidency of the Washington and Lee University. In 1897 he retired as President Emeritus.

## ENGINEERING SOCIETIES

COMING MEETINGS

**AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.**
Feb. 26-28. Midwinter Convention in New York City. Secy., F. L. Hutchinson, 33 W. 39 St. New York, N. Y.

**CENTRAL ELECTRIC RAILWAY ASSOCIATION.**
Feb. 27-28. Annual meeting at Indianapolis, Ind. Secy., A. L. Neereamer, Indianapolis, Ind.

**NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.**
Mar. 3-5. Annual meeting at Chicago, Ill. Secy., W. P. Blair, 824 Engineers Bldg., Cleveland, Ohio.

**CANADIAN MINING INSTITUTE.**
Mar. 5-7. Annual meeting at Ottawa, Canada. Secy., H. Mortimer-Lamb, Windsor Hotel, Montreal, Canada.

**VERMONT SOCIETY OF ENGINEERS.**
Mar. 10. Annual meeting at Burlington, Vt. Secy., G. A. Reed, Barre, Vt.

**NEW ENGLAND RAILROAD CLUB.**
Mar. 11. Annual meeting at Boston Mass. Secy., W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass.

**ILLINOIS WATER SUPPLY ASSOCIATION.**
Mar. 11-12. Annual meeting at Urbana, Ill. Secy., Edward Bartow, Urbana, Ill.

**AMERICAN RAILWAY ENGINEERING ASSOCIATION.**
Mar. 18-21. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 900 S. Michigan Ave., Chicago, Ill.

**BOSTON SOCIETY OF CIVIL ENGINEERS.**
Mar. 19. Annual meeting at Boston, Mass. Secy., S. E. Tinkham, 715 Tremont Temple, Boston, Mass.

**AMERICAN CHEMICAL SOCIETY.**
Mar. 25-28. Annual meeting in Milwaukee, Wis. Secy., C. L. Parsons, Box. 505, Washington, D. C.

NATIONAL FIRE PROTECTION ASSOCIATION.
Mar. 26-27. Annual meeting in New York City. Secy., Ralph Sweetland, 141 Milk St., Boston, Mass.

NEW ENGLAND STREET RAILWAY CLUB.
Mar. 27. Annual meeting at Boston, Mass. Secy., H. A. Faulkner, 12 Pearl St., Boston, Mass.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 3-5. Annual meeting at Atlantic City, N. J. Secy., J. W. Richards, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Apr. 10-12. Annual convention at St. Louis, Mo. Secy., E. T. Perkins, Chicago, Ill.

DETROIT ENGINEERING SOCIETY.
Apr. 18. Annual meeting at Detroit, Mich. Secy., F. H. Mason, 614 Moffat Bldg., Detroit, Mich.

UTAH SOCIETY OF ENGINEERS.
Apr. 18. Annual meeting at Salt Lake City, Utah. Secy., R. B. Ketchum, 702 Newhouse Bldg., Salt Lake City, Utah.

SOUTHERN GAS ASSOCIATION.
Apr. 18-20. Annual meeting at Charlotte, N. C. Secy., E. D. Brewer, Atlanta, Ga.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 24-26. Annual convention at Waterloo, Iowa. Secy., H. E. Weeks, Davenport, Iowa.

**American Society for Testing Materials**—It has been announced that the anual meeting of the society will be held at Atlantic City, June 24-28, 1913.

**American Society of Heating and Ventilating Engineers**—Following the annual meeting of the Society on Jan. 23, E. A. Scott was appointed Secretary, vice W. W. Macon, resigned.

**American Road Builders' Association**—The letter ballot on officers for the coming year resulted as follows: President, Samuel Hill; Vice-Presidents, Harold Parker, W. A. McLean, and G. W. Tillson; Secretary, E. L. Powers; and Treasurer, W. W. Crosby.

**New York State Electrical Contractors Association**—The following officers for the current year were elected at the annual meeting in Syracuse, N. Y., on Jan. 21: President, F. W. Newman; Vice-President, H. N. Smith; Secretary, G. W. Russell; and Treasurer, J. P. Burn.

**The Second International Clay Products Exhibition** will be held in the Coliseum, Chicago, Ill., from Feb. 26 to Mar. 8, in connection with the annual meetings of the National Brick Manufacturers Association, Mar. 2-8, and the National Paving Brick Manufacturers Association, Mar. 3-5.

**A Joint Meeting of Engineering Societies** of Chicago and Milwaukee is to be held at Milwaukee, Wis., on Feb. 22. Among the papers on the program are the following: "Concrete Roads and Streets," by H. J. Kuelling; "City Planning as Taught and Practiced in Europe," by L. S. Smith; "The Effect of Glare from Reflecting Surfaces on Ocular Comfort," by N. M. Black and F. A. Vaughn; and "Light and Art," by M. Luckiesh.

**Iowa Engineering Society**—The program for the annual meeting at Sioux City, on Feb. 19 to 21, included among others, the following papers of general engineering interest: "Hard Roads and Permanent Bridges," by D. B. Luten; "Municipal Franchises," by C. P. Chase; "A Proposed Engineer's License Law," by J. L. Parsons; "Purification of Water for Residences," by J. H. Dunlap; and "Hydrographic Survey for Upper Mississippi River Improvements," by C. H. Baumgartner.

**Engineers' Club of Kansas City**—Several features of particular interest marked the Club's annual meeting and banquet on Jan. 26. The principal speaker of the evening was Hugh L. Cooper, who gave an illustrated talk on the construction of the dam and power plant at Keokuk, Iowa. A model of the Keokuk Dam and power plant formed part of the table decoration and a minature transmission line, strung along the tables, supplied the lights for the banquet.

The officers elected for 1913 were: President, Daniel Bontecou; Vice-presidents, Robert Waddell, and Lee Treadwell; and Secretary-treasurer, John Prince.

**International Geological Congress**—The twelfth session will be held at Toronto, Canada, on Aug. 7-14, and preceding and following the meeting, there will be a number of excursions to points of geological interest in the Dominion. The principal paper to be delivered is a monograph on "Coal Resources of the World," which was suggested by the success attending the presentation of a similar monograph on "Iron Ore Resources of the World" at the eleventh session in Stockholm, Sweden. The paper on coal resources has been two years in preparation and will contain data collected from over 50 countries. Another topic to be discussed at the Toronto meeting is "The Influence of Depth on the Character of Metalliferous Deposits."

**American Institute of Electrical Engineers**—The 1913 summer convention is to be held at Cooperstown, N. Y., June 23 to 28.

A two-day meeting of the Institute is to be held in Pittsburgh, during the latter part of April under the auspices of the committee on the Use of Electricity in Mines and in cooperation with the Pittsburgh section.

The dates for the lectures on "Radioactivity" announced in the Feb. 20 issue of "Engineering News" as Mar. 18 and 25, and Apr. 1 and 8) have been changed to Mar. 19 and 26, and Apr. 2 and 9.

A section of the Institute has been authorized at Spokane, Wash. The annual Pacific Coast Convention is to be held at Vancouver, B. C., on Sept. 9 to 11.

**Canadian Mining Institute**—The 15th annual meeting of the Institute is scheduled for Mar. 5 to 7 at Ottawa, Ont. Over twenty papers on various subjects of mining interest are to be presented, among them the following: "The Steel Industry of Nova Scotia," by Thomas Cantley; "The Agglomeration of Iron Ores," by N. V. Hansell; "The Utilization of Exhaust Steam," by J. M. Gordon; "The Use of Rescue Apparatus in Metal Mines," by H. E. Bertling; and "Core Drilling," by P. H. Moore.

At the business session, action will be taken on four proposed amendments to the by-laws and a ballot will be taken on the following nominations of Institute officials for the ensuing year: President, A. E. Barlow; Vice-presidents, Thomas Cantley, and G. G. S. Lindsey; and Councillors, M. L. Baker, J. A. Bancroft, R. W. Brock, D. H. Browne, E. T. Corkill, T. Denis, E. Dulieux, James McEvoy, Lewis Stockett, and W. A. Williams.

**American Institute of Mining Engineers**—The feature of the annual meeting, held in New York City, Feb. 17 to 19, 1913, was an extensive alteration of the constitution, which abolishes the peculiar dual form of organization under which the society has existed hitherto, and also makes the Secretary an officer elected by the council instead of by the membership. The new council later elected Bradley Stoughton to succeed Dr. Joseph Struthers. One important item of the changes in the construction was the rejection of an amendment which (following the novel plan introduced by the American Institute of Electrical Engineers) proposed to create a grade of "Fellow."

The following are the principal new officers elected by vote of the members: President, Charles F. Rand; Vice-presidents, Karl Eilers, Waldemar Lindgren, B. B. Thayer, S. J. Jennings, T. H. Leggett, and F. W. Denton; Directors, C. W. Merrill, C. S. Robinson, E. L. Young, J. A. Holmes, J. H. Janeway Jr., J. W. Finch, J. W. Richards, E. P. Mathewson, L. D. Ricketts, R. W. Hunt, and James Gayley.

In the technical sessions, sound steel ingots were a special topic of discussion. E. A. Beck, in "The Use of Anti-piping Thermit in Casting Steel Ingots," described the best present-day practice in using thermit, and its success in German practice. "Piping and Segregation of Ingots of Steel and Ductility Tests for Openhearth Steel Rails," by P. H. Dudley, gave a summary of the author's deductions as to the essentials of mill practice for producing sound, pipeless rail steel, involving early charging into reheating furnaces to prevent pipe formation, and blooming thereafter, somewhat as recently proposed by Talbot. The Talbot method, described in our columns three months since, was discussed by its originator, Benjamin Talbot, in "The Production of Solid Steel Ingots." The personal or mill factor in producing good rails was illuminated by R. W. Hunt in "Comparative Notes on Steel Rail Rolling." Two parts of a single order for rails were rolled in a small and a large mill of the same company, under almost identical methods, and the product of the smaller mill was much better; no satisfactory explanation was given. A new form of ingot mold, which, by chilling the ingot more rapidly near the bottom shortens the depth of piping, was described by E. Gathmann in a paper "Commercial Production of Sound Steel Ingots."

Discussion of this group of papers brought forward a number of men prominent in the rail field, but no new matter was brought out. Manufacturers or their representatives held aloof from the discussion. Under these circumstances the scheduled symposium on increasing the length of ingot crop to insure elimination of bad metal, and on the cost of increased cropping, was not successful.

The remaining iron and steel papers dealt with mine valuation, a new openhearth furnace design, sintering fine ore, and other papers of practical interest, and several laboratory papers, including a full review of the structural problems of cast-iron by Prof. A. Sauveur in "Notes on Cast-iron."

In the only other session, the first after the business session, numerous papers on geology, mining, milling and products were presented, about half of them by title only.